



**Monitoring report form for CDM project activity**  
**(Version 07.0)**

*Complete this form in accordance with the instructions attached at the end of this form.*

**MONITORING REPORT**

<b>Title of the project activity</b>	Mokpo Landfill Gas Recovery Project for Electricity Generation	
<b>UNFCCC reference number of the project activity</b>	2834	
<b>Version number of the PDD applicable to this monitoring report</b>	Version 6.0	
<b>Version number of this monitoring report</b>	Version 3.0	
<b>Completion date of this monitoring report</b>	29/07/2019	
<b>Monitoring period number</b>	9 <sup>th</sup> monitoring period	
<b>Duration of this monitoring period</b>	01/01/2018 ~ 31/12/2018	
<b>Monitoring report number for this monitoring period</b>	1	
<b>Project participants</b>	Hanwha Corporation(Republic of Korea) Hanwha Corporation(Switzerland)	
<b>Host Party</b>	Republic of Korea	
<b>Applied methodologies and standardized baselines</b>	Scope 1. Energy industry Scope 13. Waste handling and disposal	
<b>Sectoral scopes</b>	Applied methodologies: - AMS I.D: Grid connected renewable electricity generation_V13 -AMS III. G: Landfill methane recovery_V06	
<b>Amount of GHG emission reductions or net anthropogenic GHG removals achieved by the project activity in this monitoring period</b>	<b>Amount achieved before 1 January 2013</b>	<b>Amount achieved from 1 January 2013</b>
	0 tCO <sub>2</sub> e	33,646 tCO <sub>2</sub> e
<b>Amount of GHG emission reductions or net anthropogenic GHG removals estimated ex ante for this monitoring period in the PDD</b>	26,874 tCO <sub>2</sub> e	

## SECTION A. Description of project activity

### A.1. General description of project activity

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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 m<sup>2</sup> and waste disposal area is 180,000 m<sup>2</sup>.

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

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

Prior to this proposed project, Mokpo Landfill was emitting landfill gas (hereinafter referred to as the LFG) into the atmosphere directly without recovery and utilization of LFG. The Project captures the 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 CO<sub>2</sub> emission reductions, the reductions were 33,646 tons CO<sub>2</sub>e over the 12 months (365 days, 01/01/2018~31/12/2018) 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**

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

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

**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**

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

- AMS I. D: Grid connected renewable electricity generation\_V13  
(<https://cdm.unfccc.int/methodologies/DB/W3TINZ7KKWCK7L8WTXFQQOFQQH4SBK>)
- AMS III. G: Landfill methane recovery\_V06  
(<https://cdm.unfccc.int/methodologies/DB/0KHNES8D09H134V3TZDQ47C3LQL3H2>)

***The referred tools on the approved methodology;***

- Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site\_V04 (It was changed to “Emissions from solid waste disposal sites\_V8.0)  
(<https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-04-v8.0.pdf>)
- Tool to calculate the emission factor for an electricity system\_V07.0  
(<https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-07-v7.0.pdf>)

### A.5. Crediting period type and duration

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Start date: 18/02/2010

Length of crediting period: 10years

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

## SECTION B. Implementation of project activity

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

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#### *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



&lt;Figure B-3&gt; The monitoring system



&lt;Figure B-2&gt; The watt-hour meter

There was no significant event affecting on the amount of reduction during the monitoring period. In addition, 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 “Mokpo LFG Power Plant Operation Manual”.

Based on “Mokpo LFG Power Plant Operation Manual”, if there is system error or any difficulties due to natural disasters, a daily work log or the lowest CH<sub>4</sub> 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:

&lt;Table B-1&gt;Operation events history

Date	Duration		Operation events	Note
07/01/2018	14:28-23:59	571 min	Monitoring system error	Flow rate is not available due to recording error. → Keep an hourly work log on the flow rate and CH <sub>4</sub> concentration
	9.52 hours			
08/01/2018	00:00-07:50	470 min	Monitoring system error	Flow rate is not available due to recording error. → Keep an hourly work log on the flow rate and CH <sub>4</sub> concentration
	7.83 hours			
11/01/2018	09:41-14:6	265 min	Maintenance of facilities - Replace actuator	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error → Excluded for estimation of emission reduction.
	14:17-14:21	4 min		
	14:34-15:42	67 min		
	5.60 hours			
12/01/2018	10:08-14:18	249 min	Maintenance of facilities - Check the fuel oil system	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error → Excluded for estimation of emission reduction.
	14:21-14:22	1 min		
	14:35-16:12	96 min		
	16:26-17:30	63 min	Error of equipment - 1st generator's trip occurred	
	6.82 hours			
18/01/2018	09:11-16:11	420 min	Maintenance of the facilities - Replace engine oil	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
	7.00 hours			
28/01/2018	00:00-02:13	133 min	Monitoring system error	Flow rate is not available due to recording error. → Keep an hourly work log on the flow rate and CH <sub>4</sub> concentration
	2.22 hours			



29/01/2018	06:56-08:43	106 min	Error of equipment - 1st generator's trip occurred	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
	08:46-14:40	353 min		
	14:57-15:01	3 min		
	15:10-18:22	191 min		
	18:42-23:59	316 min		
	16.15 hours			
30/01/2018	00:00-14:56	896 min	Error of equipment - 1st generator's trip occurred	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
	15:24-15:34	9 min	Error of equipment - 2nd generator's trip occurred	
	15.08 hours			
31/01/2018	10:00-23:59	839 min	Monitoring system error - Error of the methane analyzer communications	CH <sub>4</sub> concentration data is not available due to maintenance of the monitoring system → Keep an hourly work log on the flow rate and CH <sub>4</sub> concentration
	13.98 hours			
01/02/2018	00:00-23:59	1439 min	Monitoring system error - Error of the methane analyzer communications	CH <sub>4</sub> concentration data is not available due to maintenance of the monitoring system → Keep an hourly work log on the CH <sub>4</sub> concentration
	09:56-13:06	189 min	Maintenance of the facilities - Check the PLC card	Flow rate and CH <sub>4</sub> concentration data is not available due to maintenance of the monitoring system → Excluded for estimation of emission reduction.
	24.00 hours			
02/02/2018	00:00-23:59	1439 min	Monitoring system error - Error of the methane analyzer communications	CH <sub>4</sub> concentration data is not available due to maintenance of the monitoring system → Keep an hourly work log on the CH <sub>4</sub> concentration
	24.00 hours			
03/02/2018	00:00-23:59	1439 min	Monitoring system error - Error of the methane analyzer communications	CH <sub>4</sub> concentration data is not available due to maintenance of the monitoring system → Keep an hourly work log on the CH <sub>4</sub> concentration
	24.00 hours			
04/02/2018	00:00-23:59	1439 min	Monitoring system error - Error of the methane analyzer communications	CH <sub>4</sub> concentration data is not available due to maintenance of the monitoring system → Keep an hourly work log on the CH <sub>4</sub> concentration
	24.00 hours			
05/02/2018	00:00-23:59	1439 min	Monitoring system error - Error of the methane analyzer communications	CH <sub>4</sub> concentration data is not available due to maintenance of the monitoring system → Keep an hourly work log on the CH <sub>4</sub> concentration
	24.00 hours			
06/02/2018	00:00-15:00	900 min	Monitoring system error - Error of the methane analyzer communications	CH <sub>4</sub> concentration data is not available due to maintenance of the monitoring system → Keep an hourly work log on the CH <sub>4</sub> concentration
	15.00 hours			
09/02/2018	12:42-12:55	12 min	Error of equipment - 1st generator's trip occurred	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
	12:57-12:59	1 min		
	0.22 hours			
13/02/2018	23:06-23:59	53 min	Monitoring system error	Flow rate and CH <sub>4</sub> concentration data is not available due to maintenance of the monitoring system → Keep an hourly work log on the flow rate and CH <sub>4</sub> concentration
	0.88 hours			
14/02/2018	00:00-00:59	59 min	Monitoring system error	Flow rate and CH <sub>4</sub> concentration data is not available due to maintenance of the monitoring system → Keep an hourly work log on the flow rate and CH <sub>4</sub> concentration
	07:59-11:03	184 min	Maintenance of the facilities	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
	4.05 hours			
15/02/2018	14:45-16:06	80 min	Error of equipment - 1st generator's trip occurred	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
	17:12-17:15	2 min		
	1.37 hours			
20/02/2018	06:00-10:12	251 min	Error of equipment - 2nd generator's trip occurred	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
	4.18 hours			
27/02/2018	13:44-17:41	237 min	Maintenance of the facilities - reinforce the throttle valve	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
	3.95 hours			
02/03/2018	10:03-10:10	7 min	Error of equipment - 2nd generator's trip occurred	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error → Excluded for estimation of emission reduction.
	10:23-10:39	16 min		
	0.38 hours			

06/03/2018	01:36-09:38	482 min	Error of equipment - Error of gas line	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error → Excluded for estimation of emission reduction.
	09:39-09:45	6 min		
	09:51-09:55	3 min		
	8.18 hours			
14/03/2018	08:19-10:39	139 min	Maintenance of facilities - Check the turbo charger	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
	2.32 hours			
16/03/2018	07:50-09:51	121 min	Error of equipment - Error of actuator	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
	12:44-13:39	55 min		
	2.93 hours			
21/03/2018	07:35-09:41	125 min	Error of equipment - Error of cooling water line	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
	09:58-10:01	2 min		
	10:52-13:13	141 min	Generator shift from 1st generator to 2nd generator.	
	13:28-13:34	5 min		
	13:57-14:14	17 min		
	4.83 hours			
22/03/2018	05:56-23:59	1083 min	Maintenance of facilities - methane analyzer calibration	CH <sub>4</sub> concentration data is not available due to measurement error. → Only when the flow data is normal, the lowest CH <sub>4</sub> concentration date of the day is applied.
	18.05 hours			
23/03/2018	00:00-16:46	1006 min	Maintenance of facilities - methane analyzer calibration	CH <sub>4</sub> concentration data is not available due to measurement error. → Only when the flow data is normal, the lowest CH <sub>4</sub> concentration date of the day is applied.
	08:15-08:36	21 min	Error of equipment - Error of gas line	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
	16:02-16:46	44 min	Generator shift from 2nd generator to 1st generator.	
	17.85 hours			
26/03/2018	15:06-15:41	35 min	Error of equipment - Error of gas line	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
	0.58 hours			
27/03/2018	12:20-15:43	203 min	Error of equipment - Error of blower inverter	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
	3.38 hours			
28/03/2018	12:28-15:40	191 min	Error of equipment - Error of blower inverter	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
	3.18 hours			
29/03/2018	13:16-15:55	159 min	Error of equipment - Error of cooling water line	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
	2.65 hours			
30/03/2018	00:00-12:59	779 min	Error of equipment - Error of cooling water line	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
	12.98 hours			
05/04/2018	11:07-13:25	137 min	Maintenance of facilities - Check monitoring system	Flow rate and CH <sub>4</sub> concentration data is not available due to maintenance of the monitoring system → Keep an hourly work log on the flow rate and CH <sub>4</sub> concentration
	2.28 hours			
07/04/2018	05:36-22:31	1014 min	Maintenance of facilities - change the blower baring	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error → Excluded for estimation of emission reduction.
	22:34-22:41	6 min		
	17.00 hours			
08/04/2018	09:03-10:12	68 min	Maintenance of facilities	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error → Excluded for estimation of emission reduction.
	1.13 hours			
13/04/2018	17:01-17:48	46 min	Generator shift from 2nd generator to 1st generator.	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error → Excluded for estimation of emission reduction.
	17:54-18:02	8 min		
	0.90 hours			
17/04/2018	13:43-21:29	465 min	Error of equipment	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error → Excluded for estimation of emission reduction.
	21:31-21:47	15 min		
	8.00 hours			
20/04/2018	21:38-23:59	141 min	Monitoring system error	Flow rate and CH <sub>4</sub> concentration data is not available due to recording error. → Keep an hourly work log on the flow rate and CH <sub>4</sub> concentration
	2.35 hours			
09/05/2018	20:36-23:59	203 min	Monitoring system error	Flow rate and CH <sub>4</sub> concentration data is not available due to recording error. → Keep an hourly work log on the flow rate and CH <sub>4</sub> concentration
	3.38 hours			

				concentration
10/05/2018	00:00-07:52	472 min	Monitoring system error	Flow rate and CH <sub>4</sub> concentration data is not available due to recording error. → Keep an hourly work log on the flow rate and CH <sub>4</sub> concentration
	7.87 hours			
15/05/2018	09:07-10:33	85 min	Maintenance of facilities	Flow rate is not available due to measurement error → Excluded for estimation of emission reduction.
	1.42 hours			
16/05/2018	13:01-14:06	64 min	Maintenance of facilities - Check the pickup sensor	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error → Excluded for estimation of emission reduction.
	14:25-15:05	39 min		
	1.72 hours			
29/05/2018	16:01-16:43	42 min	Error of equipment - Error of cooling water line	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error → Excluded for estimation of emission reduction.
	16:56-17:28	31 min		
	1.22 hours			
30/05/2018	14:40-15:14	34 min	Generator shift from 2nd generator to 1st generator.	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error → Excluded for estimation of emission reduction.
	0.57 hours			
22/06/2018	05:55-07:47	112 min	Monitoring system error	Flow rate and CH <sub>4</sub> concentration data is not available due to maintenance of the monitoring system → Keep an hourly work log on the flow rate and CH <sub>4</sub> concentration
	1.87 hours			
23/06/2018	09:26-10:53	87 min	Error of equipment	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error → Excluded for estimation of emission reduction.
	1.45 hours			
26/06/2018	07:50-16:13	503 min	Black-out	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error → Excluded for estimation of emission reduction.
	8.38 hours			
27/06/2018	4:13-8:45	272 min	Black-out	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error → Excluded for estimation of emission reduction.
	23:50-23:59	9 min		
	4.68 hours			
28/06/2018	00:00-09:07	547 min	Black-out	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error → Excluded for estimation of emission reduction.
	9.12 hours			
29/06/2018	00:11-01:58	106 min	Black-out	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error → Excluded for estimation of emission reduction.
	1.77 hours			
01/07/2018	08:02-09:53	111 min	Black-out	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error → Excluded for estimation of emission reduction.
	09:53-10:11	17 min		
	10:15-11:40	85 min		
	3.55 hours			
12/07/2018	13:12-17:56	283 min	Maintenance of facilities - Replace hard disk of monitoring computer and fix the monitoring program	Flow rate and CH <sub>4</sub> concentration data is not available due to maintenance of the monitoring system → Keep an hourly work log on the flow rate and CH <sub>4</sub> concentration
	19:42-23:17	214 min		
	8.28 hours			
19/07/2018	23:05-23:53	47 min	Error of equipment - error of PLC card	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
	23:56-23:59	3 min		
	0.83 hours			
20/07/2018	00:00-00:22	22 min	Error of equipment - error of PLC card	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error → Excluded for estimation of emission reduction.
	0.37 hours			
25/07/2018	15:07-16:11	63 min	Maintenance of facilities - Replacement of oil	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
	16:44-16:56	12 min		
	1.25 hours			
27/07/2018	06:59-10:43	224 min	Maintenance of facilities - Replacement of oil level switch	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
	10:46-10:48	2 min		
	3.77 hours			
07/08/2018	08:06-23:59	953 min	Maintenance of facilities - Regular inspection by Korea Electrical Safety Corporation (KESCO).	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
	15.88 hours			
08/08/2018	00:00-16:31	991 min		Flow rate and CH <sub>4</sub> concentration data is not



	16.52 hours			available due to measurement error. → Excluded for estimation of emission reduction.
09/08/2018	10:34-11:42	67 min		Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
	12:00-12:27	27 min		
	12:46-14:34	107 min		
	14:51-14:58	7 min		
	16:54-16:57	3 min		
	16:58-18:38	99 min		
	5.17 hours			
10/08/2018	04:54-09:40	285 min	Error of equipment - error of PLC card	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
	10:00-10:15	15 min		
	10:34-12:57	143 min		
	7.38 hours			
23/08/2018	14:37-23:59	562 min	Black-out	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
	9.37 hours			
24/08/2018	00:00-07:35	455 min	Black-out	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
	7.58 hours			
03/09/2018	08:08-08:32	24 min	Maintenance of facilities - Replace engine oil	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
	0.40 hours			
04/09/2018	10:03-10:17	13 min	Generator shift from 2nd generator to 1st generator.	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
	0.22 hours			
08/10/2018	08:09-10:43	153 min	Maintenance of facilities - Replace engine oil	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
	2.55 hours			
05/11/2018	05:19-08:32	193 min	Error of equipment - Error of cooling water line	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
	09:05-10:02	57 min		
	10:16-14:02	225 min		
	14:24-23:59	575 min		
	17.50 hours			
06/11/2018	00:00-10:20	620 min	Error of equipment	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
	10:33-10:38	5 min		
	11:01-11:03	2 min		
	10.45 hours			
07/11/2018	10:03-10:08	5 min	Generator shift from 2nd generator to 1st generator.	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
	0.08 hours			
29/11/2018	17:15-17:19	3 min	Error of equipment - Error of cooling water line	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
	17:20-17:25	5 min		
	17:27-17:31	3 min		
	17:33-17:42	9 min		
	0.33 hours			
03/12/2018	09:22-10:30	67 min	Maintenance of facilities - Replacement of the water-pump oring	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
	1.12 hours			
14/12/2018	08:37-11:19	162 min	Maintenance of facilities - Replace engine oil	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
	2.70 hours			
23/12/2018	07:54-23:59	965 min	Monitoring system error	Flow rate is not available due to recording error. → Keep an hourly work log on the flow rate and CH <sub>4</sub> concentration
	16.08 hours			
24/12/2018	00:00-23:59	1439 min	Monitoring system error	Flow rate is not available due to recording error. → Keep an hourly work log on the flow rate and CH <sub>4</sub> concentration
	24.00 hours			
25/12/2018	00:00-23:59	1439 min	Monitoring system error	Flow rate is not available due to recording error.

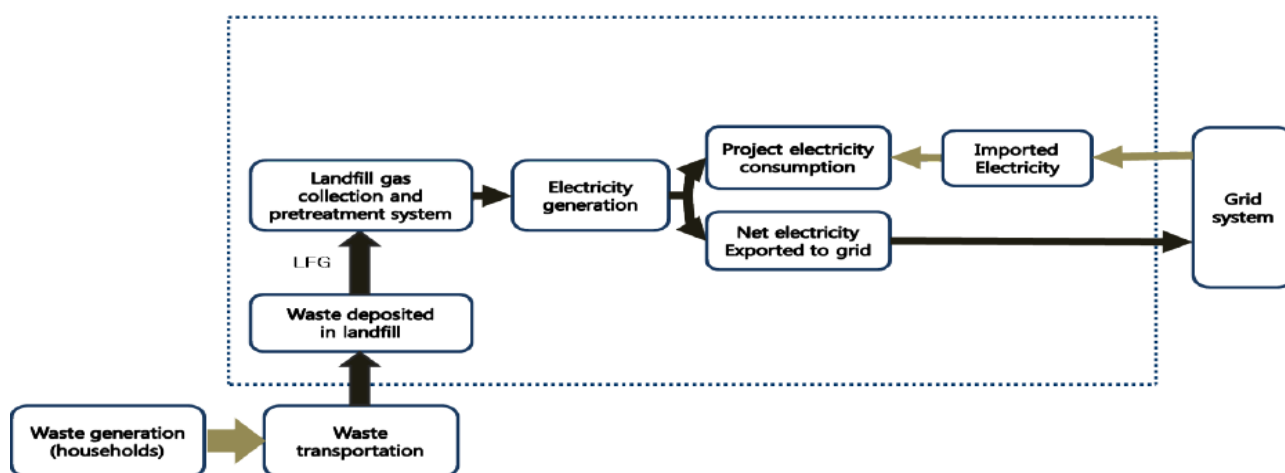
	24.00 hours			→ Keep an hourly work log on the flow rate and CH <sub>4</sub> concentration
26/12/2018	00:00-07:00	420 min	Monitoring system error	Flow rate is not available due to recording error.
	7.00 hours			→ Keep an hourly work log on the flow rate and CH <sub>4</sub> concentration

29/12/2018	03:54-09:14	320 min	Error of equipment	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
	09:52-11:25	93 min	Generator shift from 1st generator to 2nd generator.	
	11:31-11:46	15 min		
	11:51-12:08	17 min		
	12:21-12:34	12 min		
	7.62 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 m<sup>2</sup>, the amount of available landfill capacity is 2,897,000 m<sup>3</sup>. 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 m<sup>3</sup>. In addition, about 90% of the landfill is in progress. in December 2018.

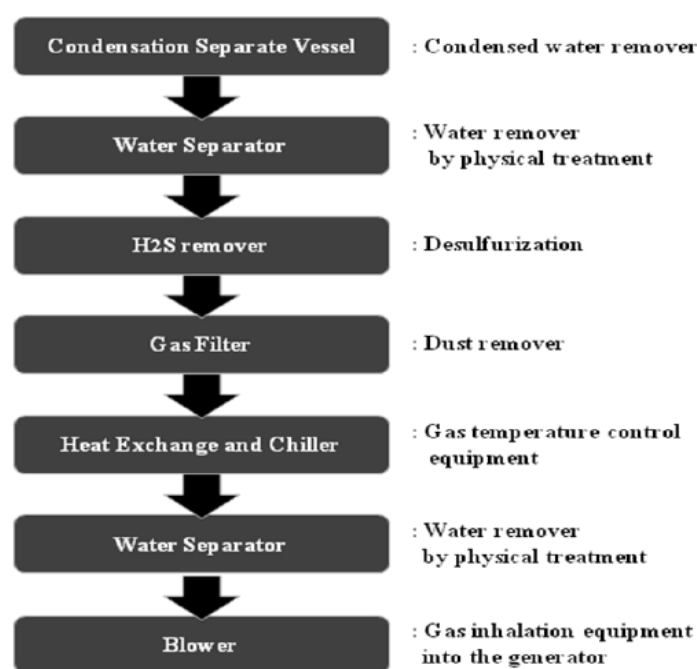
Detail history of wellhead is shown below <Table B-2>. Each of drawings has been submitted to the DOE.

<Table B-2> History of the LFG collecting system

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



<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

<b>Engine</b>	Capacity of 1.065 MW	Manufacturer	GE Jenbacher
		Engine type	JGS 320 GS-L.L
		Gas volume	522 N m <sup>3</sup> /h
	Capacity of 1.058 MW	Manufacturer	GE Jenbacher
		Engine type	J 320 GS B81
		Gas volume	450 N m <sup>3</sup> /h
<b>Generator</b>	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, standardized baselines or other methodological regulatory documents**

>> 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 7<sup>th</sup> monitoring.

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

- 1<sup>st</sup> generator engine type : JGS 320 GS-L.L

- 2<sup>nd</sup> 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 methodological regulatory documents

>> 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 2<sup>nd</sup> 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 2<sup>nd</sup> 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 2<sup>nd</sup> generator in attendance with KPX, the grid company.

$W_a$  measures generated electricity from 1<sup>st</sup> and 2<sup>nd</sup> generators;  $W_c$  measures generated electricity from 2<sup>nd</sup> 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 7<sup>th</sup> 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

### B.2.7. Changes specific to afforestation or reforestation project activity

>> NA

## SECTION C. Description of monitoring system

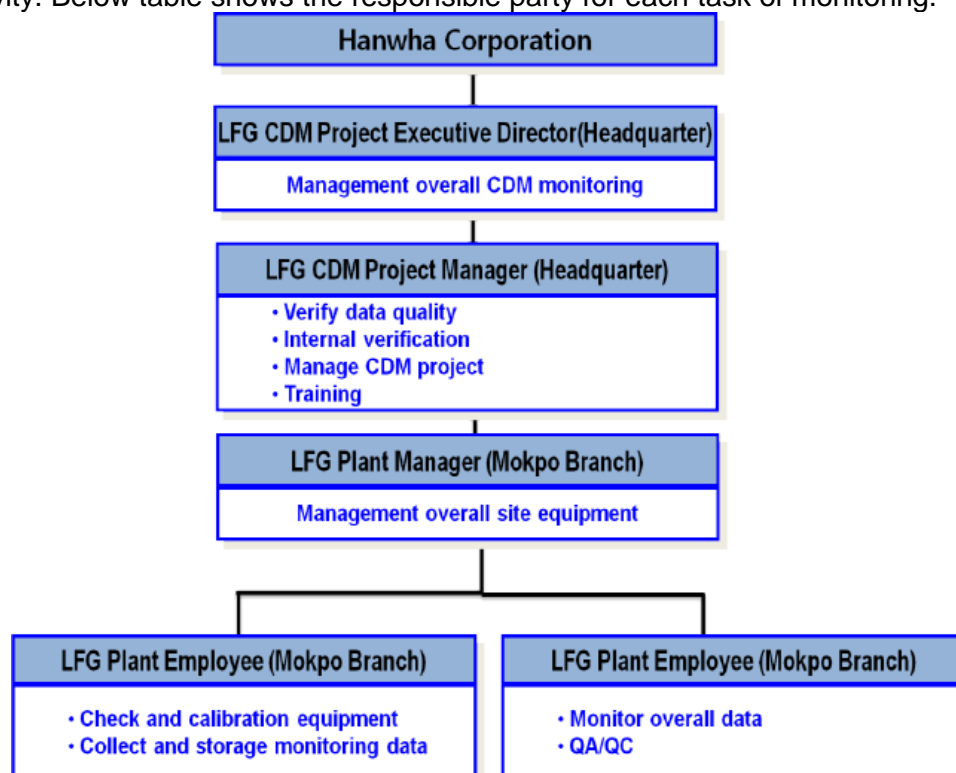
>>

Monitoring data and parameters will be monitored and their measurement method will be referred to "Mokpo LFG Power Plant Operation Manual". 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

Table 6-1 The responsible party for each task of monitoring

Item	Sub-item	Responsible person
Measure & Achieve	LFG <sub>electricity,y</sub>	Responsible person/department for the project : <ul style="list-style-type: none"><li>LFG plant manager / Mokpo operating Team of HWC Mokpo branch</li></ul>
	W <sub>CH<sub>4</sub>,y</sub>	
	EL <sub>EXP,PJT,y</sub>	
	EL <sub>IMP,PJT,y</sub>	
Measuring instrument check & Calibration	Centralized monitoring system	Responsible person/department for the project : <ul style="list-style-type: none"><li>LFG plant employee / Mokpo operating team of HWC Mokpo branch</li></ul>
	Flow meter	
	Gas analyzer	
	Watt-hour meter Responsible person/department for the project:	Responsible person/department for the project : <ul style="list-style-type: none"><li>LFG plant employee / Mokpo operating team of HWC Mokpo branch</li></ul> Responsible person/department for the project : <ul style="list-style-type: none"><li>Calibration institutions (According to “Act for measurement” and “Regulation for operation of electricity market”)</li></ul>
Establish monitoring plan		Responsible person/department for the project : <ul style="list-style-type: none"><li>LFG CDM project executive director / Green &amp; Renewable energy business team of HWC Headquarter</li><li>LFG plant manage / Mokpo operating team of HWC Mokpo branch</li><li>LFG CDM project manager / Green &amp; Renewable energy business team of HWC Headquarter</li></ul>
Task coordination		
Monitoring report		Responsible person/department for the project : <ul style="list-style-type: none"><li>LFG plant manager / Mokpo operating team of HWC Mokpo branch</li><li>LFG CDM project manager / Environment / Green &amp;</li></ul>



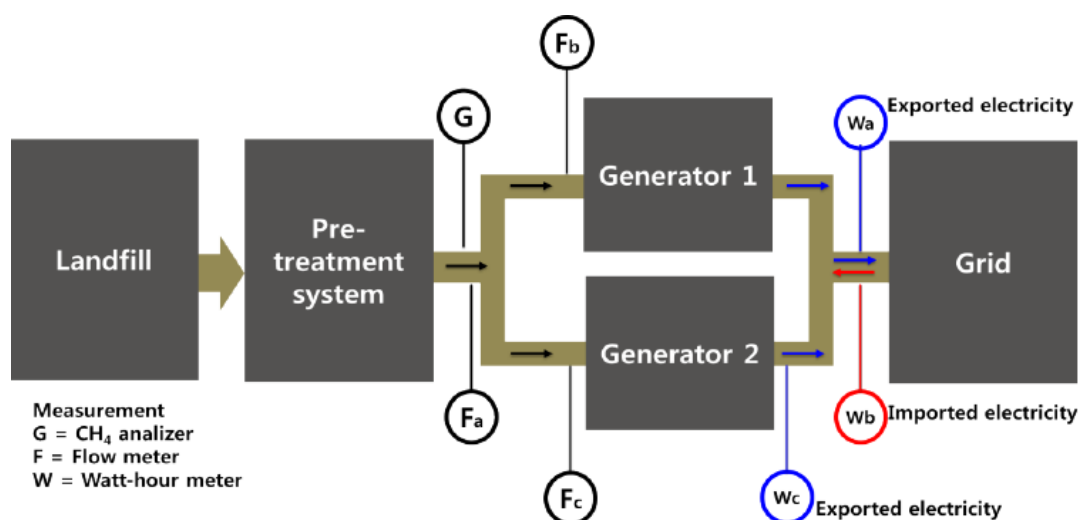
**The monitoring equipment to measure the amount of methane and electricity**

- 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 2<sup>nd</sup> generator was installed on January 27<sup>th</sup>, 2013. HWC added the watt-hour meter for 2<sup>nd</sup> generator, which requested it under the “Act on the promotion of the development, use and diffusion of new and renewable energy”. In previous installation, total amount of exported electricity out of project had been monitored by  $W_a$  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 2<sup>nd</sup> generator ( $W_c$ ) in this monitoring period, the amount of exported electricity is expressed as follows:

- Case 1 (only 1<sup>st</sup> generator operating): The amount of exported electricity =  $W_a$
- Case 2 (only 2<sup>nd</sup> generator operating): The amount of exported electricity =  $W_c$
- Case 3 (Both 1<sup>st</sup> generator and 2<sup>nd</sup> 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 Nm<sup>3</sup>/day from theoretical calculation with each flow meter's accuracy. To be conservative, if the measured value between two flow meters is out of the

range, the smaller value was applied. In this monitoring period, there was no event to be conservatively calibrated.

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 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 N<sub>2</sub> gas is used. Span calibration is for span point adjustment. For this calibration, the standard gas (CH<sub>4</sub>, CO<sub>2</sub>, and O<sub>2</sub>) was used with a concentration of each specification in accordance with manufacturer's specification.
- When data lag is occurred, the lower CH<sub>4</sub> concentration value was selected between before and after of this lagging time and the CH<sub>4</sub> quantity was calculated with this CH<sub>4</sub> concentration as a conservative manner.
- Two watt-hour meters were installed to measure the amount of exported electricity. The amount of exported electricity was recorded electronically by watt-hour meters which are connected to 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 2<sup>nd</sup> generator(W<sub>c</sub>), total amount of exported electricity out of project had been monitored by W<sub>a</sub>. After installation of W<sub>c</sub>, W<sub>c</sub> is used to measure only if 2<sup>nd</sup> generator was operated. When 1<sup>st</sup> generator or both 1<sup>st</sup> and 2<sup>nd</sup> generator operates, W<sub>a</sub> is used to measure the amount of exported electricity.
- 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<sub>b</sub>) which managed and monthly invoiced by KEPCO.

<Table C-3> Related watt-hour meters

Tag	Serial No	Accuracy level	Description	Remarks
W <sub>a</sub>	95246742	0.5s	Exported electricity (1 <sup>st</sup> generator)	
W <sub>c</sub>	50339836	0.5s	Exported electricity (2 <sup>nd</sup> generator)	A watt-hour meter for 2 <sup>nd</sup> generator (W <sub>c</sub> ) was installed on January 27 <sup>th</sup> , 2013. W <sub>c</sub> added requested it under the "Act on the promotion of the development, use and diffusion of new and renewable energy".
W <sub>b</sub>	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 the electricity market” of the 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, 2018.

Internal training for the monitoring was done by LFG CDM project manager of headquarter on November 27, 2018.

## SECTION D. Data and parameters

### D.1. Data and parameters fixed ex ante

<b>Data/Parameter</b>	Operation Margin Emission Factor ( $EF_{OM}$ )
Unit	tCO <sub>2</sub> e/MWh
Description	The generation-weighted average of CO <sub>2</sub> emission per electricity unit generated by the existing grid-connected power plants
Source of data	"Statistics of Electric Power in Korea"
Value(s) applied	0.6817
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

<b>Data/Parameter</b>	Build Margin Emission Factor ( $EF_{BM}$ )
Unit	tCO <sub>2</sub> e/MWh
Description	The generation-weighted average of CO <sub>2</sub> 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

<b>Data/Parameter</b>	CO <sub>2</sub> Emission Intensity of the Electricity displaced ( $CEF_{electricity}$ )
Unit	tCO <sub>2</sub> 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 <sub>2</sub> 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**

<b>Data/Parameter</b>	<b>F</b>
Unit	Not applied.
Description	Fraction of methane captured at the SWDS and flared, combusted or used in another manner
Measured/calculated/default	Not applied.
Source of data	Written information from the operator of the solid waste disposal site and/or site visits at the solid waste disposal site
Value(s) of monitored parameter	0
Monitoring equipment	Not applied.
Measuring/reading/recording frequency	Monitored annually.
Calculation method (if applicable)	Not applied.
QA/QC procedures	Not applied.
Purpose of data/parameter	Calculation of Baseline emission
Additional comments	Not applied.

<b>Data/Parameter</b>	<b>GWP<sub>CH<sub>4</sub></sub></b>
Unit	tCO <sub>2</sub> e/tCH <sub>4</sub>
Description	Global Warming Potential (GWP) of methane, valid for the relevant commitment period
Measured/calculated/default	Not applied.
Source of data	Decisions under UNFCCC and the Kyoto Protocol
Value(s) of monitored parameter	21(to be applied for the first commitment period of the Kyoto Protocol) 25(to be applied for the secondary commitment period of the Kyoto Protocol)
Monitoring equipment	Not applied.
Measuring/reading/recording frequency	Monitored annually.
Calculation method (if applicable)	Not applied.
QA/QC procedures	Not applied.
Purpose of data/parameter	Calculation of Baseline emission
Additional comments	Not applied.

Data/Parameter	LFG <sub>electricity,y</sub>					
Unit	N m <sup>3</sup> / y					
Description	Amount of LFG combusted in power plant					
Measured/calculated/default	Measured					
Source of data	Gas flow meters					
Value(s) of monitored parameter	<b>Data</b>	<b>Measured LFG<sub>electricity,y</sub>(N m<sup>3</sup>)</b>			<b>Applied value</b>	
		<b>F<sub>b</sub></b>	<b>F<sub>c</sub></b>	<b>F<sub>a</sub></b>	<b>F<sub>b</sub> + F<sub>c</sub></b>	<b>F<sub>a</sub></b>
	01/01/2018 ~ 18/01/2018	213,857.400	0.000	215,404.300	213,857.400	0
	19/01/2018 ~ 18/02/2018	210,328.800	97,793.700	313,233.200	308,122.500	0
	19/02/2018 ~ 18/03/2018	142,236.000	149,630.400	304,582.200	291,866.400	0
	19/03/2018 ~ 18/04/2018	241,174.700	72,536.200	301,427.100	313,710.900	0
	19/04/2018 ~ 18/05/2018	292,047.800	9,979.100	298,042.700	302,026.900	0
	19/05/2018 ~ 18/06/2018	279,795.100	7,266.500	290,899.800	287,061.600	0
	19/06/2018 ~ 18/07/2018	273,420.300	6.100	281,892.400	273,426.400	0
	19/07/2018 ~ 18/08/2018	241,915.200	21,428.200	277,427.200	263,343.400	0
	19/08/2018 ~ 18/09/2018	246,251.100	8,410.100	265,404.100	254,661.200	0
	19/09/2018 ~ 18/10/2018	256,159.500	0.000	254,428.000	256,159.500	0
	19/10/2018 ~ 18/11/2018	238,124.100	7,113.600	237,238.600	245,237.700	0
	19/11/2018 ~ 18/12/2018	211,515.100	26,548.800	226,440.800	238,063.900	0
	19/12/2018 ~ 31/12/2018	86,542.700	17,395.700	102,387.700	103,938.400	0
	01/01/2018 ~ 31/12/2018	2,933,367.800	418,108.400	3,368,808.100	3,351,476.200	
<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<sub>electricity,y</sub>' 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 m<sup>3</sup>/day from theoretical calculation with each flow meter's accuracy. In this monitoring period, there was not the error between them.</p> <p>All measured data for the crediting period has been submitted to the DOE as a spreadsheet named "Mokpo_9<sup>th</sup> MR_2834_Emission Reduction".</p>						



Monitoring equipment	<b>Tag</b>	<b>F<sub>a</sub> (main)</b>	<b>F<sub>b</sub> (1<sup>st</sup> generator)</b>	<b>F<sub>c</sub> (2<sup>nd</sup> generator)</b>
	Serial No	GR-160994	GR-160995	GR-170320
	Accuracy level	0.5% of F.S	0.5% of F.S	0.5% of F.S
	Type	Thermal Mass Flow Meter		
	Calibration Frequency	3 years		
	Date of installation	09/09/2016	09/09/2016	20/03/2017
	Date of last calibration	02/09/2016	02/09/2016	20/03/2017
	Validity	01/09/2019	01/09/2019	19/03/2020
	Calibration Entity	Golden Rules Co., Ltd.	Golden Rules Co., Ltd.	Golden Rules Co., Ltd.
	<ul style="list-style-type: none"> <li>Measured automatically and continuously by integrating flow meters.</li> <li>The measured data is monitored by a computer and Mokpo operation team should check it continuously.</li> <li>To ensure accuracy, the flow meters are subject to regular maintenance and testing. The flow meter is calibrated every three years.</li> <li>The achieved data is kept during the crediting period as well as two years after that.</li> <li>Daily data is documented in paper and achieved in electronic file.</li> </ul> <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.			

<b>Data/Parameter</b>	<b>W<sub>CH<sub>4</sub></sub>,y</b>																
Unit	%																
Description	Methane fraction in LFG																
Measured/calculated/default	Measured																
Source of data	Methane analyzer																
Value(s) of monitored parameter	<p>- Weighted average CH<sub>4</sub> 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 CH<sub>4</sub> (%) (Weighted average CH<sub>4</sub> concentration)</th></tr> </thead> <tbody> <tr> <td>01/01/2018 ~ 31/12/2018</td><td>52.328</td></tr> </tbody> </table> <p>All measured data for the crediting period has been submitted to the DOE as a spreadsheet.</p>	Date	Measured CH <sub>4</sub> (%) (Weighted average CH <sub>4</sub> concentration)	01/01/2018 ~ 31/12/2018	52.328												
Date	Measured CH <sub>4</sub> (%) (Weighted average CH <sub>4</sub> concentration)																
01/01/2018 ~ 31/12/2018	52.328																
Monitoring equipment	<table border="1"> <thead> <tr> <th>Tag</th><th>W<sub>CH<sub>4</sub></sub>,y</th></tr> </thead> <tbody> <tr> <td>Serial No</td><td>A8M7282T</td></tr> <tr> <td>Accuracy level</td><td>Linearity 1% of F.S Repeatability 0.5% of F.S</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>26/03/2018</td></tr> <tr> <td>Validity</td><td>25/03/2021</td></tr> <tr> <td>Calibration Entity</td><td>Korea Research Institute of Standards and Science</td></tr> </tbody> </table> <ul style="list-style-type: none"> <li>• Methane fraction is measured with continuous gas analyzer.</li> <li>• The measured data is monitored by a computer and Mokpo operation team should check it continuously.</li> <li>• To ensure accuracy, the gas analyzer is subject to regular maintenance and testing regime in accordance with the manufacturer's specification.</li> <li>• The methane analyzer is calibrated every three years.</li> <li>• The achieved data is kept during the crediting period as well as two years after that.</li> <li>• Daily data is documented in paper and achieved in electronic file.</li> </ul>	Tag	W <sub>CH<sub>4</sub></sub> ,y	Serial No	A8M7282T	Accuracy level	Linearity 1% of F.S Repeatability 0.5% of F.S	Type	Infrared gas analyzer	Calibration frequency	3 years	Date of last calibration	26/03/2018	Validity	25/03/2021	Calibration Entity	Korea Research Institute of Standards and Science
Tag	W <sub>CH<sub>4</sub></sub> ,y																
Serial No	A8M7282T																
Accuracy level	Linearity 1% of F.S Repeatability 0.5% of F.S																
Type	Infrared gas analyzer																
Calibration frequency	3 years																
Date of last calibration	26/03/2018																
Validity	25/03/2021																
Calibration Entity	Korea Research Institute of Standards and Science																
Measuring/reading/recording frequency	Measured automatically.																
Calculation method (if applicable)	Not applied.																
QA/QC procedures	<p>To ensure accuracy, the gas analyzer is subject to regular maintenance and testing regime in accordance with the manufacturer's specification. The methane analyzer is calibrated every three years.</p> <p>In order to deal with the uncertainty caused by delayed calibration, -0.01% of linearity error applied at 26/03/2018.</p>																
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	<b>Date</b>	<b><math>W_a</math></b>	<b><math>W_c</math></b>	<b>Total <math>EL_{EXP}</math> (MWh)</b>
	01/01/2018 ~ 18/01/2018	249.799	0.000	249.799
	19/01/2018 ~ 18/02/2018	285.539	133.179	418.718
	19/02/2018 ~ 18/03/2018	180.070	193.409	373.479
	19/03/2018 ~ 18/04/2018	279.242	75.433	354.675
	19/04/2018 ~ 18/05/2018	337.552	9.862	347.414
	19/05/2018 ~ 18/06/2018	345.959	7.855	353.814
	19/06/2018 ~ 18/07/2018	331.163	0.000	331.163
	19/07/2018 ~ 18/08/2018	293.887	20.984	314.871
	19/08/2018 ~ 18/09/2018	331.293	9.452	340.745
	19/09/2018 ~ 18/10/2018	333.397	0.000	333.397
	19/10/2018 ~ 18/11/2018	293.908	8.628	302.536
	19/11/2018 ~ 18/12/2018	260.699	32.533	293.233
	19/12/2018 ~ 31/12/2018	100.110	22.303	122.413
	01/01/2018 ~ 31/12/2018	3,622.619	513.637	4,136.256
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.				

Monitoring equipment	<b>Tag</b>	<b>W<sub>a</sub></b>	<b>W<sub>c</sub></b>
	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	07/08/2018 ~ 09/08/2018	07/08/2018 ~ 09/08/2018
	Validity	06/08/2020	06/08/2020
	Calibration Entity	KTC (Korea Testing Certification)	
	<ul style="list-style-type: none"><li>Two watt-hour meters were installed to measure the amount of exported electricity.</li><li>The amount of exported electricity is measured automatically by certified watt-hour meters. The measured data is transferred to KPX. It is checked and achieved daily, weekly, monthly in electronic way by the Mokpo operation team.</li><li>This project involves the installation of two exported electricity watt-hour meters. W<sub>a</sub> watt-hour meter had been installed as measure of the amount of exported electricity in Mokpo LFG plant. Additionally a watt-hour for 2<sup>nd</sup> generator (W<sub>c</sub>) was installed on January 27<sup>th</sup>, 2013. W<sub>c</sub> added requested it under the “Act on the promotion of the development, use and diffusion of new and renewable energy”.</li><li>In previous installation of W<sub>c</sub>, W<sub>c</sub> is used to measure only if 2<sup>nd</sup> generator was operated. When 1<sup>st</sup> generator or both 1<sup>st</sup> and 2<sup>nd</sup> generator operates, W<sub>a</sub> is used to measure the amount of exported electricity.</li><li>The achieved data is kept during the crediting period as well as two years after that.</li><li>Daily data is documented in paper and achieved in electronic file.</li></ul>		
	Measuring/reading/recording frequency	Measured automatically.	
Calculation method (if applicable)	Not applied.		
QA/QC procedures	<ul style="list-style-type: none"><li>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.</li><li>The calibration of watt-hour meters will be carried out before the installation initially and periodically performed at least once in 2 years.</li></ul>		
Purpose of data/parameter	Calculation of Baseline emission		
Additional comments	Not applied.		

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

Value(s) of monitored parameter	<b>Date</b>	<b>Measured EL<sub>IMP</sub> (MWh)</b>
	01/01/2018 ~ 18/01/2018	1.104
	19/01/2018 ~ 18/02/2018	1.464
	19/02/2018 ~ 18/03/2018	0.888
	19/03/2018 ~ 18/04/2018	1.392
	19/04/2018 ~ 18/05/2018	0.096
	19/05/2018 ~ 18/06/2018	0.048
	19/06/2018 ~ 18/07/2018	0.648
	19/07/2018 ~ 18/08/2018	1.584
	19/08/2018 ~ 18/09/2018	0.072
	19/09/2018 ~ 18/10/2018	0.072
	19/10/2018 ~ 18/11/2018	0.816
	19/11/2018 ~ 18/12/2018	0.144
	19/12/2018 ~ 31/12/2018	0.672
	01/01/2018 ~ 31/12/2018	<b>9.000</b>
	<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>01/01/2018 to 31/12/2018, 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 19<sup>th</sup> of last month to 18<sup>th</sup> 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	<b>Tag</b>	<b>W<sub>b</sub></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	07/08/2018 ~ 09/08/2018
	Validity	06/08/2020
	Calibration Entity	Korea Testing Certification (KTC)
	<ul style="list-style-type: none"> <li>The amount of imported electricity will be measured automatically by certified watt-hour meter. The project participant will check the amount of the imported electricity at the web site (<a href="http://cyber.kepcoco.kr">http://cyber.kepcoco.kr</a>) and get the paper bill from KEPCO monthly.</li> <li>The achieved data is kept during the crediting period as well as two years after that.</li> <li>The monthly data is achieved in paper bill from KEPCO.</li> </ul>	
Measuring/reading/recording frequency	Measured automatically.	
Calculation method (if applicable)	Not applied.	
QA/QC procedures	<ul style="list-style-type: none"> <li>To ensure accuracy, the watt-hour meter is subject to regular maintenance and testing regime complying with the "Measures Act" in Republic of Korea.</li> <li>The calibration of watt-hour meter will be carried out before the installation initially and periodically performed at least once in 2 years.</li> </ul>	
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**

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

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

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

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

Parameter	Unit	Description
LFG <sub>electricity,y</sub>	N m <sup>3</sup>	LFG flared or used as fuel in the year 'y'.
w <sub>CH<sub>4</sub>,y</sub>	%	Methane content in LFG in the year 'y' (mass fraction).
D <sub>CH<sub>4</sub>,y</sub>	kg/N m <sup>3</sup>	Density of methane at normal conditions in the year 'y'. (Source: ACM0001 ver.11)
GWP <sub>CH<sub>4</sub></sub>	tCO <sub>2</sub> /tCH <sub>4</sub>	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<sub>electricity,y</sub> is automatically measured at normal condition by a flow meter, and the temperature and pressure are not monitored separately. Thus, density of methane at normal conditions in the year 'y' is measured in kg/ Nm<sup>3</sup>.

Methane content is measured by gas analyzer.

**E.2. Calculation of project emissions or actual net removals**

>>

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

Parameter	Unit	Description
EL <sub>IMP,PJT,y</sub>	MWh	The quantity of imported electricity from grid-connected system to project activity during the year, 'y'.

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

**E.3. Calculation of leakage 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 <sub>y</sub>	LFG <sub>electricity,y</sub>	W <sub>CH<sub>4</sub></sub>	D <sub>CH<sub>4</sub>,y</sub>	GWP <sub>CH<sub>4</sub></sub>	MD <sub>reg,y</sub>	EL <sub>EXP,PJT,y</sub>	EL <sub>IMP,PJT,y</sub>	CEF	Leakage
01/01/2018 ~ 31/12/2018	33,646.003	3,351,476.200	52.328	0.0007168	25	0	4,136.3	9.000	0.5375	0

	Baseline GHG emissions or baseline net GHG removals (t CO <sub>2</sub> e)	Project GHG emissions or actual net GHG removals (t CO <sub>2</sub> e)	Leakage GHG emissions (t CO <sub>2</sub> e)	GHG emission reductions or net anthropogenic GHG removals (t CO <sub>2</sub> e)		
				Before 01/01/2013	From 01/01/2013	Total amount
<b>Total</b>	33,650.841	4.838	0	0	33,646	33,646

**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 <sub>2</sub> e)	Amount estimated ex ante for this monitoring period in the PDD (t CO <sub>2</sub> e)
33,646	26,874

**E.5.1. Explanation of calculation of “amount estimated ex ante for this monitoring period in the PDD”**

&gt;&gt;

Year	ER <sub>y,estimated, PDD</sub>	=	ER <sub>y,CH<sub>4</sub>, PDD</sub>	+	ER <sub>y,electricity, PDD</sub>
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

Detail Values estimated in ex-ante calculation of registered PDD over this 9<sup>th</sup> monitoring period are shown in the below table.

Year	ER <sub>y</sub>	ER <sub>CH<sub>4</sub></sub>				ER <sub>electricity</sub>			
			BE <sub>y,CH<sub>4</sub></sub>	PE <sub>y, CH<sub>4</sub></sub>	Leakage		BE <sub>y,electricity</sub>	PE <sub>y,electricity</sub>	Leakage
2018 (365days)	26,874	23,343	23,343	0	0	3,531	3,532	1	0

**E.6. Remarks on increase in achieved emission reductions**

&gt;&gt;

**Values applied in ex-ante calculation of the registered CDM-PDD: 26,874 tCO<sub>2</sub>e**

The emission reductions increased to 25.2% during the monitoring period compared to the expected emission reductions that are on the registered CDM-PDD.

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

**Updated value of  $GWP_{CH_4}$  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  $GWP_{CH_4}$  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 17.5% increase in this monitoring period (When the previous  $GWP_{CH_4}$  is applied, total reduction is 28,617 tCO<sub>2</sub>e).

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

The PDD estimate was based on 50% CH<sub>4</sub> concentration but the actual concentration exceeds 52.328% in this monitoring period. (When the 50% CH<sub>4</sub> concentration is applied, total reduction is 32,247 tCO<sub>2</sub>e).

The increased CH<sub>4</sub> concentration had the greatest effect on increasing the emission reduction followed by the GWP update.

Since the increase in CH<sub>4</sub> 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 CH<sub>4</sub> concentration.

**Quantity of LFG generated from the landfill site.**

The LFG flow was estimated to be 6.46 m<sup>3</sup>/min (on the registered CDM-PDD in 2018) but the actual average flow was 6.92 m<sup>3</sup>/min during the monitoring period. In other words, there was 7.16% of the difference between the theoretical and the actual values. When the 50% CH<sub>4</sub> concentration and 21 GWP were applied, the LFG<sub>y</sub> per minute is 8.7m<sup>3</sup>/min and the difference with theoretical and the actual values are 34.6%.

Content	Year	LFG <sub>y</sub> (m <sup>3</sup> /min)	=	BE <sub>CH<sub>4</sub>,SWDS,y</sub>	/	GWP	/	D <sub>CH<sub>4</sub></sub>	/	W <sub>CH<sub>4</sub>,y</sub>	/	MIN <sub>year</sub>
PDD	2018	6.46	=	23,343	/	21	/	0.0007168	/	0.5	/	480,000
MR	2018	6.92	=	31,427	/	25	/	0.0007168	/	0.52	/	480,000

**E.7. Remarks on scale of small-scale project activity**

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NA

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

<b>Project participant and/or responsible person/ entity</b>	<input checked="" type="checkbox"/> Project participant <input checked="" type="checkbox"/> Person/entity responsible for completing the CDM-MR-FORM
<b>Organization name</b>	Hanwha Corporation
<b>Street/P.O. Box</b>	86 Cheonggyecheon-ro, Jung-gu
<b>Building</b>	22F. Hanwha Bldg.
<b>City</b>	Seoul
<b>State/region</b>	
<b>Postcode</b>	04541
<b>Country</b>	Republic of Korea
<b>Telephone</b>	+82-2-729-3543
<b>Fax</b>	+82-2-729-3509
<b>E-mail</b>	<a href="mailto:jihyunpark@hanwha.com">jihyunpark@hanwha.com</a>
<b>Website</b>	<a href="http://english.hanwhacorp.co.kr/">http://english.hanwhacorp.co.kr/</a>
<b>Contact person</b>	Jihyun Park
<b>Title</b>	
<b>Salutation</b>	Ms.
<b>Last name</b>	Park
<b>Middle name</b>	
<b>First name</b>	Jihyun
<b>Department</b>	Merchandise Business Department
<b>Mobile</b>	
<b>Direct fax</b>	
<b>Direct tel.</b>	
<b>Personal e-mail</b>	

## Document information

<i>Version</i>	<i>Date</i>	<i>Description</i>
07.0	31 May 2019	Revision to: <ul style="list-style-type: none"> <li>• Ensure consistency with version 02.0 of the “CDM project standard for project activities” (CDM-EB93-A04-STAN);</li> <li>• Add a section on remarks on the observance of the scale limit of small-scale project activity during the crediting period;</li> <li>• Add "changes specific to afforestation or reforestation project activity" as a possible post-registration changes;</li> <li>• Clarify the reporting of net anthropogenic GHG removals for A/R project activities between two commitment periods;</li> <li>• Make editorial improvements.</li> </ul>
06.0	7 June 2017	Revision to: <ul style="list-style-type: none"> <li>• Ensure consistency with version 01.0 of the “CDM project standard for project activities” (CDM-EB93-A04-STAN);</li> <li>• Make editorial improvements.</li> </ul>
05.1	4 May 2015	Editorial revision to correct version numbering.
05.0	1 April 2015	Revisions to: <ul style="list-style-type: none"> <li>• Include provisions related to delayed submission of a monitoring plan;</li> <li>• Provisions related to the Host Party;</li> <li>• Remove reference to programme of activities;</li> <li>• Overall editorial improvement.</li> </ul>
04.0	25 June 2014	Revisions to: <ul style="list-style-type: none"> <li>• Include the Attachment: Instructions for filling out the monitoring report form (these instructions supersede the "Guideline: Completing the monitoring report form" (Version 04.0));</li> <li>• Include provisions related to standardized baselines;</li> <li>• Add contact information on a responsible person(s)/ entity(ies) for completing the CDM-MR-FORM in A.6 and Appendix 1;</li> <li>• Change the reference number from <i>F-CDM-MR</i> to <i>CDM-MR-FORM</i>;</li> <li>• Editorial improvement.</li> </ul>
03.2	5 November 2013	Editorial revision to correct table in page 1.
03.1	2 January 2013	Editorial revision to correct table in section E.5.
03.0	3 December 2012	Revision required to introduce a provision on reporting actual emission reductions or net GHG removals by sinks for the period up to 31 December 2012 and the period from 1 January 2013 onwards (EB 70, Annex 11).
02.0	13 March 2012	Revision required to ensure consistency with the "Guidelines for completing the monitoring report form" (EB 66, Annex 20).
01.0	28 May 2010	EB 54, Annex 34. Initial adoption.
Decision Class: Regulatory Document Type: Form Business Function: Issuance Keywords: monitoring report		