FUZHOU HONGMIAOLING LANDFILL GAS TO ELECTRICITY PROJECT

Document Prepared by Climate Bridge (Shanghai) Ltd.

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Project Title	**Fuzhou Hongmiaoling Landfill Gas to Electricity Project**
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1 PROJECT DETAILS

1.1 Summary Description of the Implementation Status of the Project

Fuzhou Hongmiaoling Landfill Gas to Electricity Project (hereafter referred to as the project) is a landfill gas (LFG) collection and utilization project located in Fuzhou City, Fujian Province, People's Republic of China. The project involves the installation of a gas collection system, a leachate drainage system, flaring equipment, and an electricity generation plant at Fuzhou Hongmiaoling Landfill. The generators use methane in the landfill gas to produce electricity. The electricity generated is sold to Fujian Provincial Power grid, an integral part of East China Power Grid, to replace the electricity otherwise generated by coal-fired power plants. The project initially planned to install three GE gas engines with a total capacity of 2.5 MW, but only two GE gas engines, each with 834 kW, were installed with a total capacity of 1.668 MW, according to the *Purchase Contract* signed between the project proponent and the engine seller. Excess landfill gas, and all the gas collected in the absence of electricity generation is flared.

The project started construction on 30/09/2006 and the operation started on 19/11/2007. The project was registered as a CDM project on 17/11/2008 (CDM reference: 1732), with a fixed ten-year crediting period from 17/11/2008 to 16/11/2018. A total number of 115,091 CERs, corresponding to GHG emission reductions of 115,091 tCO_2e, have been issued under the CDM program for three monitoring periods between 17/11/2008 and 30/06/2011. The project was also registered as a VCS project (VCS reference: 253) and 49,617 VCUs have been issued for the monitoring period 19/11/2007 to 16/11/2008.

During the reported monitoring period from 01/07/2011 to 18/11/2017, the project went through a 16-month shut down[1] from 10 a.m. 19/12/2012 to 06 a.m. 31/03/2014, during which the 1# generator was switched on and operated for a short timeslot from 4 a.m. to 5 a.m. 15/10/2013. The shut-down did not impact the normal operation of the project during the rest of the reported monitoring period. The total operation time of the two generators was 43,340 hours and 43,312 hours, respectively, during the monitoring period. The net electricity exported was 29,366 MWh and the quantity of methane destroyed was 7,386 tCH_4. The GHG emission reductions achieved during the reported monitoring period are 231,904 tCO_2e.

1.2 Sectoral Scope and Project Type

[1] The local authorities performed an expansion activity on the landfill where the project is located, due to which the project activity had to be completely shut down. After the expansion was completed, the project restored its gas collection and power generation system and has been in normal operation since then.

The project is categorized into the sectoral scope 13 (waste handling and disposal) and the sectoral scope 1 (energy industries [renewable / non-renewable sources]).

The project is not a grouped project.

1.3 Project Proponent

Organization name	**Fujian Tianyi Renewable Energy Technology & Utilization Co., Ltd.**
Contact person	QIU Yuhong
Title	General Manager
Address	Hongmiaoling Landfill Site, Jinan District, Fuzhou City, Fujian Province, China, 350012
Telephone	+86 021-23019950
Email	3542346576@qq.com

1.4 Other Entities Involved in the Project

Organization name	**Climate Bridge (Shanghai) Ltd.**
Role in the Project	Consultant
Contact person	GAO Zhiwen
Title	General Manager
Address	Block B, Level 24, Jiangong Mansion, 33 Fushan Road, Pudong New Area, Shanghai, China 200120
Telephone	+86 21 62462036
Email	gao.zhiwen@climatebridge.com

1.5 Project Start Date

The project start date is 19/11/2007, the day when the operation started.

1.6 Project Crediting Period

As per *VCS Standard v4.1*, projects registered under other GHG programs are not eligible for VCU issuance beyond the end of the total project crediting period under those programs. Since the

project has a fixed ten-year crediting period of 17/11/2008 to 16/11/2018 under the CDM program, it is not eligible for VCU issuance beyond 16/11/2018.

The project adopts a fixed ten-year crediting period from 19/11/2007 to 18/11/2017 under the VCS program.

1.7 Project Location

The project activity is located at bottom of Lianhua Mountain, Hongmiaoling, Fujian Province, People's Republic of China. It is 17 km northwest of Fuzhou City. The GPS coordinates of the project site is north latitude of 26°05′ and east longitude of 119°18′. The location is shown in **Figure 1.1**.

Figure 1.1 Location of the project site

1.8 Title and Reference of Methodology

The project applies the following methodologies:

The approved consolidated baseline and monitoring methodology ACM0001: "Consolidated methodology for landfill gas project activities" (Version 05)

https://cdm.unfccc.int/filestorage/C/D/M/CDMWF_AM_V66J3B48JSA77ID045VYMSLQX2BGFI/EB28_repan09_ACM0001_ver05.pdf?t=UWR8cXVzYW9nfDA8AEb5rGrqKVX2g3QPT0BJ

The approved methodology AMS-I.D. "Grid connected renewable electricity generation" (Version 11)

https://cdm.unfccc.int/filestorage/C/D/M/CDMWF_AM_UYF1PQNDY5FZ4VH4HZ28FYAP13SI9W/AMS_I.D_rev_ver11.pdf?t=dU18cXVzYXF5fDDrnomzotptQjJlFoBKbDEk

The following tools are also applied:

Tool for the Demonstration and Assessment of Additionality (Version 03)

https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-01-v3.pdf

Tool to determine project emissions from flaring gases containing methane to calculate the project emissions (Version 01)

https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-06-v1.pdf

1.9 Participation under other GHG Programs

The project was registered as a CDM project on 17/11/2008 (CDM reference: 1732), with a fixed ten-year period from 17/11/2008 to 16/11/2018, as per the registered CDM PDD. A total number of 115,091 CERs, corresponding to GHG emission reductions of 115,091 tCO_2e, have been issued under the CDM program for the monitoring periods between 17/11/2008 and 30/06/2011, as is shown in **Table 1.1**.

Table 1.1 List of GHG emission reduction credits issued under other GHG programs

Monitoring Period	GHG Emission Reductions (tCO_2e)	Credit	Program
17/11/2008 – 31/05/2009	22,584	CER	CDM
01/06/2009 – 30/06/2010	51,961	CER	CDM
01/07/2010 – 30/06/2011	40,546	CER	CDM

Refer to the link below for more detailed information:
https://cdm.unfccc.int/Projects/DB/DNV-CUK1204757435.62/view

1.10 Other Forms of Credit

Emission trading programs and other blinding Limits

The project does not reduce GHG emissions from activities that are included in an emission trading program or any other mechanism that includes GHG allowance trading.

Other forms of environmental credit

The project has not sought or received another form of GHG-related environmental credit, including renewable energy certificates, for this monitoring period.

The emission reductions achieved during this monitoring period will only be used for VCU issuance request under the VCS program.

1.11 Sustainable Development

The project contributes to achieving China's national energy policy and sustainable development strategy as well as the Unites Nations' Sustainable Development Goals (SDGs) in the following aspects:

GHG emission reductions

The project utilizes methane for electricity; during the reported monitoring period, it destroyed 7,386 tons of CH_4 which would have been released into the atmosphere, and exported a net quantity of 29,366 MWh electricity to the Fujian Provincial Power Gird that is a part of the East China Power Grid, displacing part of the fossil fuel power generation. By achieving 231,904 tCO_2e of GHG emission reductions during the reported monitoring period, the project represents an urgent action to combat climate change and its impacts (SDG 13[2]).

Contribution to environment protection

The project activity has a positive effect on local people's health. Contaminated leachate and surface run-off from landfills can affect the quality of underground and surface water, consequently polluting the local environment and harming the health of local population. The uncontrolled release of landfill gas can also lead to risk of explosions. By managing this landfill properly, the environmental health risks and the possibility of explosions are significantly reduced, ensuring healthy lives and promoting well-being for all at all ages (SDG 3[3]).

Clean energy demonstration

The project is the first LFG to electricity project in the province and one of the first projects around China. Advanced international technology is employed, which helps the technology transfer. The project provides an example that can be used by others that may want to develop modern and more efficient clean generation of electricity using landfill gas throughout China. Therefore, the project ensures access to affordable, reliable, sustainable and modern energy for all (SDG 7[4]).

Providing job opportunities

By directly creating new jobs and helping residents get rid of poverty, the project promotes sustained, inclusive and sustainable economic growth, full and production employment and decent work for all (SDG 8[5]).

[2] https://sdgs.un.org/goals/goal13

[3] https://sdgs.un.org/goals/goal3

[4] https://sdgs.un.org/goals/goal7

[5] https://sdgs.un.org/goals/goal8

2 SAFEGUARDS

2.1 No Net Harm

The environmental impact assessment report of the project concluded that the project would not have a significant negative environmental impact. Please refer to Section D of the registered PDD for more detailed information.

The project brings many socio-economic benefits to the local people, and such as new job opportunities, reduced risk of explosions etc., as mentioned in Section 1.11. The project does not result in any negative socio-economic impacts.

In conclusion, the construction and operation of this project did not and will not result in any significant environmental impacts or any negative socio-economic impact.

2.2 Local Stakeholder Consultation

Local stakeholder consultation before the project construction

To guarantee a successful implementation of the project with stakeholders' interests taken into account, the project proponent sent out in 2005 some questionnaires to the stakeholders in the surrounding area of Fuzhou Hongmiaoling Landfill Gas to Electricity Project for comments of the project construction, which was an important section of the EIA report. The interviewees were nearby villagers, employees of the Fuzhou Hongmiaoling Landfill and staff members of the local district government. 50 copies of questionnaires were distributed, and 47 replies were received. The interviewees showed a quite positive attitude towards the project.

The information of the interviewees is presented in **Table 2.1**.

Table 2.1 Information of the interviewees

Age	18-30	30-40	40-50	50-60	Above 60
	5	10	18	13	1
Education level of the interviewee	Middle school	High school	College	Others	
	30%	28%	12%	30%	
Gender	Male			Female	
	60%			40%	

The survey results are presented below.

<u>Awareness of the proposed project:</u>

85% of the interviewees heard about the project and 15% did not know the project. After the surveyors introduced and explained the project to them, they all had a certain degree of knowledge of the project.

Attitudes towards the project construction

64% of the interviewees fully agreed to the project and believed the proposed project would bring significant social benefits and environmental benefits; 32% shows agreed to the project construction; 13% showed some doubts about the environmental benefits; 2% of the interviewees were indifferent to the construction.

Concerns on impacts during the construction

55% of the interviewees were concerned about the potential ecological damage, 30% were concerned about the noise impact, and 15% were concerned about the pollution of the construction waste.

Concerns on impacts after the construction

50% of the interviewees believed that the project might raise some environmental problems such as malodor and air pollution. 30% of the interviewees believed that it might do harm to the local ecological system, and 20% paid most attention to the noise from the power plant operation.

Impacts on public benefits of the project construction

"Do you think your benefits will be impacted by the project construction?" When asked this question, 83% of the interviewees indicated no negative impact from the project. 17% believed that its impacts were small, but none of them considered the impacts serious.

The survey showed that most stakeholders investigated supported the construction of the project. In addition, the economic and environment improvements brought by the project were largely considered positive. The biggest concern is on the pollution from the project, which had been well considered and resolved in the EIA report approved by the local government. In general, the local community expressed strong positive comments on the effects that the project activity would make on the local economy and infrastructure. Consequently, no modifications to the plans were considered necessary due to comments received.

Local stakeholder consultation during the reported monitoring period

During the project operation, local stakeholder consultation activities are also held on a regular basis. During the reported monitoring period, the project proponent carried out questionnaire surveys for five separate times in March 2012, April 2014, March 2015, March 2016 and March 2017. Questionnaires, with questions concerning the impacts of the project operation in different aspects, were distributed to local residents working and living around the area. No negative comments were received. The respondents generally expressed their support to the project.

2.3 AFOLU-Specific Safeguards

Not applicable.

3 IMPLEMENTATION STATUS

3.1 Implementation Status of the Project Activity

The project only has one project site with one phase. The project initially planned to install three GE gas engines with a total capacity of 2.5 MW, but only two GE gas engines, each with 834 kW, were installed with a total capacity of 1.668 MW, according to the *Purchase Contract* signed between the project proponent and the engine seller. The gas engines' model is JGS 316 GS-L.L. Their key technical indicators are listed in **Table 3.1**.

The project started construction on 30/09/2006 and the operation started on 19/11/2007. The project was registered as a CDM project on 17/11/2008 (CDM reference: 1732). A total number of 115,091 CERs, corresponding to GHG emission reductions of 115,091 tCO_2e, have been issued under the CDM program for three monitoring periods between 17/11/2008 and 30/06/2011; the project is also a VCS project, and 49,617 VCUs have been issued for the monitoring period 19/11/2007 – 16/11/2008, as presented in **Table 3.2**.

Table 3.1 Technical indicators of the GE gas engines

GE model	JGS 316 GS-L.L
Electric power output	834 kW
Electricity efficiency	39.8%
Total efficiency	39.8%
Methane number (Mz)	100
Calorific value (Hu)	4 kWh/Nm^3
Fuel gas volume	524 ± 5% Nm^3/h

Table 3.2 Implementation timeline of the project

Event	Date
Construction started	30/09/2006
Operation started	19/11/2007

CDM registration date	17/11/2008
VCS registration	18/12/2009
First VCU issuance (monitoring period: 19/11/2007 – 16/11/2008)	15/01/2010
First CER issuance (monitoring period: 17/11/2008 – 31/05/2009)	04/05/2011
Second CER issuance (monitoring period: 01/06/2009 – 30/06/2010)	02/11/2011
Third CER issuance (monitoring period: 01/07/2010 – 30/06/2011)	06/08/2012

During the reported monitoring period from 01/07/2011 to 12/31/2015, the project went through a 16-month shut down from 10 a.m. 19/12/2012 to 06 a.m. 31/03/2014, during which the 1# generator was switched on and operated for a short timeslot from 4 a.m. to 5 a.m. 15/10/2013. The shut-down did not impact the normal operation of the project during the rest of the reported monitoring period.

On 15/02/2015, the meter used to monitor the electricity exported and imported was replaced by a new one with an accuracy of 0.2S; the replacement does not impact the applied methodologies, the monitoring plan or the emission reductions calculation.

All staff had received well-organized trainings and studies were held regularly to ensure the good performance. The project operation and monitoring followed the requirements of registered PDD and the applied methodologies, and no event that would impact the applicability of the applied methodology occurred. The total operation time of the two generators was 43,340 hours and 43,312 hours, respectively, during the monitoring period. The net electricity exported was 29,366 MWh and the quantity of methane destroyed was 7,386 tCH_4. The GHG emission reductions achieved during the reported monitoring period are 231,904 tCO_2e.

3.2 Deviations

3.2.1 Methodology Deviations

No methodology deviation occurred during the reported monitoring period.

3.2.2 Project Description Deviations

According to the monitoring plan in the registered PDD, the meter that measures the amount of electricity exported and imported $EL_{EX,LFG}$ and EL_{IMP} (see Section 4.2) should have an accuracy level of 0.2S. However, the accuracy of the meter actually installed is 0.5S, lower than the described one in the registered PDD. To address this non-compliance, a deviation description was submitted to the CDM EB on 01/02/2010 (reference: I-DEV0291) for the verification of the first CDM monitoring period from 17/11/2008 to 31/05/2009. The correction of the metered data was considered necessary for the calculation of baseline emissions. A conservative solution to address the noncompliance was proposed and approved:

- the amount of electricity exported out of the project boundary $EL_{EX,LFG}$ must be decreased by 0.5% of the meter readings;
- the amount of electricity imported to meet project requirements EL_{IMP} must be increased by 0.5% of the meter readings.

Refer to the link below for more detailed information about this deviation and the associated solution: https://cdm.unfccc.int/Projects/deviations/03324.

During this monitoring period, the old meter was replaced by a new one with an accuracy of 0.2S on 15/02/2012 (refer to Section 4.2 for details). The accuracy of the new meter is 0.2S, no lower than the described one in the registered PDD. Therefore, the same solution is applied to calculate the corrected values of $EL_{EX,LFG}$ and EL_{IMP} from 01/07/2011 to 29/02/2012. From 01/03/2012 onwards, the correction solution was no longer applied.

3.3 Grouped Projects

Not applicable.

4 DATA AND PARAMETERS

4.1 Data and Parameters Available at Validation

Data / Parameter	$CEF_{electricity,y}$
Data unit	tCO_2/MWh
Description	CO_2 emission intensity of the electricity displaced during year y
Source of data	Registered PDD
Value applied	0.8541

Justification of choice of data or description of measurement methods and procedures applied	Its value has been determined in the registered PDD as the combined margin emission factor of East China Power Grid based on the data available at that time.
Purpose of Data	Calculation of baseline emissions
Comments	-

The registered PDD also defined the following parameters for the purpose of $CEF_{electricity,y}$ calculation: EF_{OM}, EF_{BM}, NCV_i, $EF_{CO2,i}$, *Carbon Oxidation Factor*. These parameters are not elaborated in this Monitoring Report for the sake of the readability.

Data / Parameter	L_0
Data unit	Nm^3/Mg of waste
Description	Potential CH_4 generation capacity
Source of data	Registered PDD
Value applied	159.0
Justification of choice of data or description of measurement methods and procedures applied	L_0 is a constant that represents the potential capacity of a landfill to generate CH_4.
Purpose of Data	-
Comments	-

Data / Parameter	k
Data unit	$year^{-1}$
Description	Rate of methane generation
Source of data	Registered PDD
Value applied	0.05
Justification of choice of data or description of measurement methods and procedures applied	*k* is a constant that determines the rate of landfill gas generation. The first-order decomposition rate assumes that *k* values before and after peak landfill gas generation are the same.
Purpose of Data	-
Comments	-

4.2 Data and Parameters Monitored

Data / Parameter	$LFG_{total,y}$

<table>
<tr><td>Data unit</td><td>m³</td></tr>
<tr><td>Description</td><td>Total amount of LFG captured</td></tr>
<tr><td>Source of data</td><td>Measured</td></tr>
<tr><td>Description of measurement methods and procedures to be applied</td><td>A flow meter (measuring F_t in Figure 4.3) has been installed to measure this value.</td></tr>
<tr><td>Frequency of monitoring/recording</td><td>Continuously</td></tr>
<tr><td>Value monitored</td><td>23,758,019.464 during the entire monitoring period. See Section 5.4 for details.</td></tr>
<tr><td>Monitoring equipment</td><td>
<table>
<tr><td>Type</td><td>TBQ-15012 DN150</td></tr>
<tr><td>Serial number</td><td>X6126012</td></tr>
<tr><td>Accuracy class</td><td>2.0% for Q_{min}~$0.2Q_{max}$; 1.0% for $0.2Q_{max}$~Q_{max}</td></tr>
<tr><td>Calibration frequency</td><td>Every two years according to JJG 1037-2008</td></tr>
<tr><td>Calibration date</td><td>20/07/2010
10/07/2012
02/07/2014
22/06/2016</td></tr>
<tr><td>Validity</td><td>21/06/2018</td></tr>
</table>
</td></tr>
<tr><td>QA/QC procedures to be applied</td><td>The flow meter was calibrated every two years according to national standard JJG 1037-2008. The calibration reports are kept by the project proponent.</td></tr>
<tr><td>Purpose of the data</td><td>Calculation of baseline emissions</td></tr>
<tr><td>Calculation method</td><td>-</td></tr>
<tr><td>Comments</td><td>-</td></tr>
</table>

Data / Parameter	$\boldsymbol{LFG_{electricity,y}}$
Data unit	m³
Description	The total quantity of LFG for power generation

<table>
<tr><td>Source of data</td><td>Measured</td></tr>
<tr><td>Description of measurement methods and procedures to be applied</td><td>A flow meter (measuring F_e in Figure 4.3) has been installed to measure this value.</td></tr>
<tr><td>Frequency of monitoring/recording</td><td>Continuously</td></tr>
<tr><td>Value monitored</td><td>23,621,743.900 during the entire monitoring period. See Section 5.4 for details.</td></tr>
<tr><td>Monitoring equipment</td><td><table>
<tr><td>Type</td><td>TBQ-15012 DN150</td></tr>
<tr><td>Serial number</td><td>X6126011</td></tr>
<tr><td>Accuracy class</td><td>2.0% for Q_{min}~0.2Q_{max}; 1.0% for 0.2Q_{max}~Q_{max}</td></tr>
<tr><td>Calibration frequency</td><td>Every two years according to JJG 1037-2008</td></tr>
<tr><td>Calibration date</td><td>01/11/2010
10/10/2012
07/09/2014
04/09/2016</td></tr>
<tr><td>Validity</td><td>03/09/2018</td></tr>
</table></td></tr>
<tr><td>QA/QC procedures to be applied</td><td>The flow meter was calibrated every two years according to national standard JJG 1037-2008. The calibration reports are kept by the project proponent.</td></tr>
<tr><td>Purpose of the data</td><td>Calculation of baseline emissions</td></tr>
<tr><td>Calculation method</td><td>-</td></tr>
<tr><td>Comments</td><td></td></tr>
</table>

Data / Parameter	$\boldsymbol{LFG_{flare,y}}$
Data unit	m^3
Description	The total quantity of LFG for flaring
Source of data	Measured

Description of measurement methods and procedures to be applied	A flow meter (measuring F_f in **Figure 4.3**) has been installed to measure this value.
Frequency of monitoring/recording	Continuously
Value monitored	136,243.995 during the entire monitoring period. See Section 5.4 for details.
Monitoring equipment	<table><tr><td>Type</td><td>TBQ-15012 DN150</td></tr><tr><td>Serial number</td><td>X6126013</td></tr><tr><td>Accuracy class</td><td>2.0% for Q_{min}~$0.2Q_{max}$; 1.0% for $0.2Q_{max}$~Q_{max}</td></tr><tr><td>Calibration frequency</td><td>Every two years according to JJG 1037-2008</td></tr><tr><td>Calibration date</td><td>28/09/2010 22/09/2012 18/09/2014 04/09/2016</td></tr><tr><td>Validity</td><td>03/09/2018</td></tr></table>
QA/QC procedures to be applied	The flow meter was calibrated every two years according to national standard JJG 1037-2008. The calibration reports are kept by the project proponent.
Purpose of the data	Calculation of baseline emissions
Calculation method	-
Comments	

Data / Parameter	$\boldsymbol{PE_{flare,y}}$
Data unit	tCO_2
Description	Project emissions from flaring of the residual gas stream in year *y*
Source of data	Calculated. See Section 5.4 for details.
Description of measurement methods	Calculated following Equation (5) in Section 5.4: $PE_{flare,y} = \sum TM_{RG,h} \times (1 - \eta_{flare,h}) \times \frac{GWP_{CH_4}}{1000}$

and procedures to be applied	
Frequency of monitoring/recording	Continuously
Value monitored	1,199.520 during the entire monitoring period. See Section 5.4 for details.
Monitoring equipment	-
QA/QC procedures to be applied	-
Purpose of the data	Calculation of baseline emissions
Calculation method	As per the "Tool to determine project emissions from flaring gases containing methane" (version 1)
Comments	-

Data / Parameter	w_{CH_4}
Data unit	m^3CH_4 / m^3LFG
Description	Methane fraction in the LFG
Source of data	Measured
Description of measurement methods and procedures to be applied	A gas analyzer has been installed to measure this value.
Frequency of monitoring/recording	Monitored continuously
Value monitored	Varying from 39% to 49%. See Section 5.4 for details.
Monitoring equipment	

Type	Polytron IR EX
Serial number	NA
Accuracy class	Max linearity error is 4.0%
Calibration frequency	Monthly according to the product manual
Calibration	As the product manual requires monthly calibrations, it would be unnecessary to list every calibration date during the six-year monitoring period. Therefore, the last calibration before the monitoring period

			and the validity of the last calibration are shown below: 05/06/2011 (date of the last calibration before the monitoring period) ~ 06/12/2017 (validity date of the last calibration for the monitoring period)
QA/QC procedures to be applied	The gas analyzer is maintained and calibrated according to the product manual, in line with the manufacturer's requirements, as required by the registered PDD. The analyzer was calibrated using standard gases containing methane in N_2 for 20%, 50% and 80% level and ambient air for zero level. The standard gases are purchased from gas suppliers who provide their gas products contained in gas cylinders as well as *Reference Material Certificate*. The gas analyzer measures the ambient air (which contains 0% methane) to return the reading to 0; and then the gas tube of the gas analyzer is inserted into the cylinder containing the standard gas, wait until the reading stabilizes and wait for another 30 seconds, adjust the reading to the actual concentration of the standard gas; the same procedures are repeated for the standard gases with 20%, 50% and 80% of methane in N_2. The calibration procedures conducted by the project proponent are in compliance with the requirement in the registered PDD.		
Purpose of the data	Calculation of baseline emissions		
Calculation method	-		
Comments	-		

Data / Parameter	$\boldsymbol{Degree}$
Data unit	°C
Description	Temperature of the landfill gas
Source of data	Measured
Description of measurement methods and procedures to be applied	Three thermometers have been installed to monitor the temperatures of three landfill gas streams: - T_t, total landfill gas; - T_e, landfill gas sent to the electricity generators; - T_f, landfill gas sent to the flare system.
Frequency of monitoring/recording	Measured continuously
Value monitored	Varying from -10.12 °C to 49.65 °C

Monitoring equipment		T_t	T_e	T_f
	Type	SBWZ-2480-236	SBWZ-2480-236	SBWZ-2480-236
	Serial number	11	8	7
	Accuracy	0.25%	0.25%	0.25%
	Calibration frequency	Every year according to JJG 1183-2007		
	Calibration date	25/11/2010 25/11/2011 25/11/2012 25/11/2014 25/11/2015 25/11/2016	25/11/2010 25/11/2011 25/11/2012 25/11/2014 25/11/2015 25/11/2016	25/11/2010 25/11/2011 25/11/2012 25/11/2014 25/11/2015 25/11/2016
	Validity	24/11/2017	24/11/2017	24/11/2017
QA/QC procedures to be applied	The thermometers were calibrated annually according to national standard JJG 1183-2007. Since the project was not in operation throughout the entire year of 2013, no calibration was carried out during that year.			
Purpose of the data	Calculation of baseline emissions			
Calculation method	-			
Comments	The thermometers were out of calibration from 31/03/2014 to 25/11/2014. Please refer to Note 11 of page 41 for the measure taken to calculate the ER in a conservative way.			

Data / Parameter	$\boldsymbol{P}$
Data unit	Pa
Description	The pressure of landfill gas
Source of data	Measured
Description of measurement methods and procedures to be applied	Three manometers have been installed to measure the pressures of three landfill gas streams: - P_t, total landfill gas; - P_e , landfill gas sent to the electricity generators; - P_f, landfill gas sent to the flare system.
Frequency of monitoring/recording	Measured continuously

Value monitored	Varying from 0 to 40.11
Monitoring equipment	

	P_t	P_e	P_f
Type	ST200 A143M	ST200 A143M	ST200 A143M
Serial number	77601	77603	77604
Accuracy	0.2%	0.2%	0.2%
Calibration frequency	Every year according to JJG 882-2004		
Calibration date	03/12/2010 03/12/2011 03/12/2012 03/12/2014 03/12/2015 03/12/2016	03/12/2010 03/12/2011 03/12/2012 03/12/2014 03/12/2015 03/12/2016	03/12/2010 03/12/2011 03/12/2012 03/12/2014 03/12/2015 03/12/2016
Validity	02/12/2017	02/12/2017	02/12/2017

QA/QC procedures to be applied	The manometers are operated and maintained as per the specifications prescribed by the manufacturer. The meters are calibrated according to national standard JJG 882-2004. Since the project was not in operation throughout the entire year of 2013, no calibration was carried out during that year.
Purpose of the data	Calculation of baseline emissions
Calculation method	-
Comments	The manometers were out of calibration from 31/03/2014 to 03/12/2014. Please refer to Note 11 of page 41 for the measure taken to calculate the ER in a conservative way.

Data / Parameter	$EL_{EX,LFG}$
Data unit	MWh
Description	Total amount of electricity exported out of the project
Source of data	Measured
Description of measurement methods and procedures to be applied	A bi-directional electricity meter has been installed to measure this value.

<table>
<tr><td>Frequency of monitoring/recording</td><td>Measured continuously and recorded monthly</td></tr>
<tr><td>Value monitored</td><td>29,571.557 during the entire monitoring period. See Section 5.4 for details.</td></tr>
<tr><td>Monitoring equipment</td><td>The information on the meter used before 15/02/2012 is presented below.
<table>
<tr><td>Type</td><td>DSSD132</td></tr>
<tr><td>Serial number</td><td>10048065</td></tr>
<tr><td>Accuracy class</td><td>0.5 S</td></tr>
<tr><td>Calibration frequency</td><td>Yearly according to DLT448-2000</td></tr>
<tr><td>Calibration date</td><td>18/05/2011</td></tr>
<tr><td>Validity</td><td>17/05/2012</td></tr>
</table>
The meter was replaced by a new one on 15/02/2012. The information on the meter used after that date is presented below.
<table>
<tr><td>Type</td><td>DSZ331</td></tr>
<tr><td>Serial number</td><td>010087263770</td></tr>
<tr><td>Accuracy class</td><td>0.2 S</td></tr>
<tr><td>Calibration frequency</td><td>Yearly according to DLT448-2000 (valid until 30/04/2017) and DLT 448-2016 (valid since 01/05/2017)</td></tr>
<tr><td>Calibration date</td><td>15/02/2012
10/02/2013
08/02/2014
05/02/2015
01/02/2016
30/01/2017</td></tr>
<tr><td>Validity</td><td>29/01/2018</td></tr>
</table></td></tr>
</table>

QA/QC procedures to be applied	The electricity meter was calibrated and maintained according to national standard DLT 448-2000 (valid until 30/04/2017) and DLT 448-2016 (valid since 01/05/2017). The meter readings were cross-checked with electricity sales receipts, and the conservative values were selected for calculation.
Purpose of the data	Calculation of baseline emissions
Calculation method	-
Comments	-

Data / Parameter	EL_{IMP}
Data unit	MWh
Description	Total amount of electricity imported to meet the project requirements
Source of data	Measured
Description of measurement methods and procedures to be applied	A bi-directional electricity meter has been installed to measure this value.
Frequency of monitoring/recording	Measured continuously and recorded monthly
Value monitored	205.025 during the entire monitoring period. See Section 5.4 for details.
Monitoring equipment	The information on the meter used before 15/02/2012 is presented below. Type: DSSD132 Serial number: 10048065 Accuracy class: 0.5S Calibration frequency: Yearly according to DLT448-2000 Calibration date: 18/05/2011 Validity: 17/05/2012 The meter was replaced by a new one on 15/02/2012. The information on the meter used after that date is presented below.

	<table><tr><td>Type</td><td>DSZ331</td></tr><tr><td>Serial number</td><td>010087263770</td></tr><tr><td>Accuracy class</td><td>0.2S</td></tr><tr><td>Calibration frequency</td><td>Yearly according to DLT448-2000 (valid until 30/04/2017) and DLT448-2016 (valid since 01/05/2017)</td></tr><tr><td>Calibration date</td><td>15/02/2012 10/02/2013 08/02/2014 05/02/2015 01/02/2016 30/01/2017</td></tr><tr><td>Validity</td><td>29/01/2018</td></tr></table>
QA/QC procedures to be applied	The electricity meter was calibrated and maintained according to national standard DLT448-2000 (valid until 30/04/2017) and DLT 448-2016 (valid since 01/05/2017). The meter readings were cross-checked with electricity purchase receipts, and the conservative values were selected for calculation.
Purpose of the data	Calculation of baseline emissions
Calculation method	-
Comments	-

Data / Parameter	T_{flare}
Data unit	°C
Description	Temperature in the exhaust gas of the flare
Source of data	Measured
Description of measurement methods and procedures to be applied	A Type N thermocouple has been installed to measure the temperature of the exhaust gas stream. If the temperature is above 500°C, it indicates that a significant amount of gas is being burnt and that the flares are in operation.

Frequency of monitoring/recording	Measured continuously
Value monitored	Varying from 0°C to 55°C. See the table below for details.

Period	T_{flare} (°C)	Period	T_{flare} (°C)
01/07/2011 - 31/07/2011	18~55	01/04/2015 - 30/04/2015	0~18
01/08/2011 - 31/08/2011	12~30	01/05/2015 - 31/05/2015	0~20
01/09/2011 - 30/09/2011	0~21	01/06/2015 - 30/06/2015	2~20
01/10/2011 - 31/10/2011	0~24	01/07/2015 - 31/07/2015	3~25
01/11/2011 - 30/11/2011	1~34	01/08/2015 - 31/08/2015	4~28
01/12/2011 - 31/12/2011	0~18	01/09/2015 - 30/09/2015	0~20
01/01/2012 - 31/01/2012	1~26	01/10/2015 - 31/10/2015	0~34
01/02/2012 - 29/02/2012	0~24	01/11/2015 - 30/11/2015	5~30
01/03/2012 - 31/03/2012	5~26	01/12/2015 - 31/12/2015	12~31
01/04/2012 - 30/04/2012	3~33	01/01/2016 - 31/01/2016	2~35
01/05/2012 - 31/05/2012	1~18	01/02/2016 - 29/02/2016	0~23
01/06/2012 - 30/06/2012	0~16	01/03/2016 - 31/03/2016	0~20
01/07/2012 - 31/07/2012	0~15	01/04/2016 - 30/04/2016	1~34
01/08/2012 - 31/08/2012	4~32	01/05/2016 - 31/05/2016	0~19
01/09/2012 - 30/09/2012	0~15	01/06/2016 - 30/06/2016	3~23
01/10/2012 - 31/10/2012	0~27	01/07/2016 - 31/07/2016	1~18
01/11/2012 - 30/11/2012	4~29	01/08/2016 - 31/08/2016	2~16
01/12/2012 - 31/12/2012	0~43	01/09/2016 - 30/09/2016	0~14
01/01/2013 - 31/12/2013	0	01/10/2016 - 31/10/2016	0~16
01/01/2014 - 31/01/2014	0	01/11/2016 - 30/11/2016	0~21
01/02/2014 - 28/02/2014	0	01/12/2016 - 31/12/2016	0~24
01/03/2014 - 31/03/2014	1~26	01/01/2017 - 31/01/2017	0~30

	01/04/2014 - 30/04/2014: 5~18 01/05/2014 - 31/05/2014: 0~20 01/06/2014 - 30/06/2014: 0~20 01/07/2014 - 31/07/2014: 1~14 01/08/2014 - 31/08/2014: 3~24 01/09/2014 - 30/09/2014: 1~18 01/10/2014 - 31/10/2014: 11~36 01/11/2014 - 30/11/2014: 0~36 01/12/2014 - 31/12/2014: 0~16 01/01/2015 - 31/01/2015: 0~30 01/02/2015 - 28/02/2015: 1~23 01/03/2015 - 31/03/2015: 0~20 01/02/2017 - 29/02/2017: 5~18 01/03/2017 - 31/03/2017: 1~14 01/04/2017 - 30/04/2017: 2~24 01/05/2017 - 31/05/2017: 1~20 01/06/2017 - 30/06/2017: 0~18 01/07/2017 - 31/07/2017: 0~20 01/08/2017 - 31/08/2017: 1~13 01/09/2017 - 30/09/2017: 1~24 01/10/2017 - 31/10/2017: 4~18 01/11/2017 - 18/11/2017: 0~20
Monitoring equipment	Type: Type N Serial number: NA Range: -40°C ~ 1000°C Calibration: The calibration was not carried out during the reported monitoring period. However, this does not impact the monitoring plan, as the temperature is low and the value of $\eta_{flare,h}$ is taken as 0, which is conservative.
QA/QC procedures to be applied	The thermocouple is replaced or calibrated every year.
Purpose of the data	Calculation of baseline emissions
Calculation method	-
Comments	-

Data / Parameter	Operation hours of the power plant
Data unit	hour/year

Description	Operation hours of the power plant
Source of data	Measured
Description of measurement methods and procedures to be applied	Monitored by the computer system
Frequency of monitoring/recording	Continuously
Value monitored	43,340 hours for the #1 generator and 43,312 hours for the #2 generator during the entire monitoring period. See the table below for monthly data.

Period	Operation hours (h)		Period	Operation hours (h)	
	#1	#2		#1	#2
01/07/2011 - 31/07/2011	720	736	01/04/2015 - 30/04/2015	691	695
01/08/2011 - 31/08/2011	725	713	01/05/2015 - 31/05/2015	728	704
01/09/2011 - 30/09/2011	685	665	01/06/2015 - 30/06/2015	709	685
01/10/2011 - 31/10/2011	726	732	01/07/2015 - 31/07/2015	707	719
01/11/2011 - 30/11/2011	687	699	01/08/2015 - 31/08/2015	717	705
01/12/2011 - 31/12/2011	719	743	01/09/2015 - 30/09/2015	683	705
01/01/2012 - 31/01/2012	698	716	01/10/2015 - 31/10/2015	695	687
01/02/2012 - 29/02/2012	667	659	01/11/2015 - 30/11/2015	716	718
01/03/2012 - 31/03/2012	712	712	01/12/2015 - 31/12/2015	717	699
01/04/2012 - 30/04/2012	690	690	01/01/2016 - 31/01/2016	718	704
01/05/2012 - 31/05/2012	717	717	01/02/2016 - 29/02/2016	670	660
01/06/2012 - 30/06/2012	704	680	01/03/2016 - 31/03/2016	723	701
01/07/2012 - 31/07/2012	714	706	01/04/2016 - 30/04/2016	709	685
01/08/2012 - 31/08/2012	703	719	01/05/2016 - 31/05/2016	719	703
01/09/2012 - 30/09/2012	684	690	01/06/2016 - 30/06/2016	687	695
01/10/2012 - 31/10/2012	732	718	01/07/2016 - 31/07/2016	700	718

	01/11/2012 - 30/11/2012	683	705	01/08/2016 - 31/08/2016	716	714
	01/12/2012 - 31/12/2012	419	407	01/09/2016 - 30/09/2016	692	690
	01/01/2013 - 31/12/2013	0	0	01/10/2016 - 31/10/2016	709	721
	01/01/2014 - 31/01/2014	0	0	01/11/2016 - 30/11/2016	693	681
	01/02/2014 - 28/02/2014	0	0	01/12/2016 - 31/12/2016	707	731
	01/03/2014 - 31/03/2014	18	18	01/01/2017 - 31/01/2017	720	716
	01/04/2014 - 30/04/2014	685	699	01/02/2017 - 29/02/2017	634	644
	01/05/2014 - 31/05/2014	716	710	01/03/2017 - 31/03/2017	730	704
	01/06/2014 - 30/06/2014	680	708	01/04/2017 - 30/04/2017	673	713
	01/07/2014 - 31/07/2014	724	726	01/05/2017 - 31/05/2017	704	712
	01/08/2014 - 31/08/2014	723	711	01/06/2017 - 30/06/2017	711	685
	01/09/2014 - 30/09/2014	686	698	01/07/2017 - 31/07/2017	728	690
	01/10/2014 - 31/10/2014	734	714	01/08/2017 - 31/08/2017	708	732
	01/11/2014 - 30/11/2014	699	677	01/09/2017 - 30/09/2017	710	710
	01/12/2014 - 31/12/2014	712	722	01/10/2017 - 31/10/2017	717	701
	01/01/2015 - 31/01/2015	717	705	01/11/2017 - 18/11/2017	669	701
	01/02/2015 - 28/02/2015	649	659			
	01/03/2015 - 31/03/2015	702	730			
Monitoring equipment	The computer					
QA/QC procedures to be applied	The equipment was operated and maintained in line with manufacturer's recommendations to ensure high quality output.					
Purpose of the data	-					
Calculation method	-					
Comments	-					

Data / Parameter	$fv_{CH_4,RG,h}$
Data unit	%
Description	Volumetric fraction of methane in the residual gas on dry basis in hour *h*

<table>
<tr><td>Source of data</td><td>Measured</td></tr>
<tr><td>Description of measurement methods and procedures to be applied</td><td>A gas analyzer has been installed to measure this value.</td></tr>
<tr><td>Frequency of monitoring/recording</td><td>Continuously monitored</td></tr>
<tr><td>Value monitored</td><td>Varying from 39% to 49%. See Section 5.4 for details.</td></tr>
<tr><td>Monitoring equipment</td><td>
<table>
<tr><td></td><td>Gas analyzer</td></tr>
<tr><td>Type</td><td>Polytron IR EX</td></tr>
<tr><td>Serial number</td><td>NA</td></tr>
<tr><td>Accuracy class</td><td>Max linearity error is 4.0%</td></tr>
<tr><td>Calibration frequency</td><td>Monthly according to the product manual</td></tr>
<tr><td>Calibration dates</td><td>As the product manual requires monthly calibrations, it would be unnecessary to list every calibration date during the six-year monitoring period. Therefore, the last calibration before the monitoring period and the validity of the last calibration are shown below:

05/06/2011 (date of the last calibration before the monitoring period) ~ 06/12/2017 (validity date of the last calibration for the monitoring period)</td></tr>
</table>
</td></tr>
<tr><td>QA/QC procedures to be applied</td><td>The gas analyzer is maintained and calibrated according to the product manual, in line with the manufacturer’s requirements, as required by the registered PDD.

The analyzer was calibrated using standard gases containing methane in N_2 for 20%, 50% and 80% level and ambient air for zero level. The standard gases are purchased from gas suppliers who provide their gas products contained in gas cylinders as well as Reference Material Certificate. The gas analyzer measures the ambient air (which contains 0% methane) to return the reading to 0; and then the gas tube of the gas analyzer is inserted into the cylinder containing the standard gas, wait until the reading stabilizes and wait for another 30 seconds, adjust the reading to the actual concentration of the standard gas; the same</td></tr>
</table>

	procedures are repeated for the standard gases with 20%, 50% and 80% of methane in N_2. The calibration procedures conducted by the project proponent are in compliance with the requirement in the registered PDD.
Purpose of the data	Calculation of project emissions
Calculation method	-
Comments	-

Data / Parameter	$FV_{RG,h}$
Data unit	m^3/h
Description	Volumetric flow rate of the residual gas in day basis at normal conditions in the hour *h*
Source of data	Measured
Description of measurement methods and procedures to be applied	A flow meter has been installed to measure this value.
Frequency of monitoring/recording	Continuously
Value monitored	See the table below for average monthly values

Period	$FV_{RG,h}$ (m^3/h)	Period	$FV_{RG,h}$ (m^3/h)
01/07/2011 - 31/07/2011	537.959	01/04/2015 - 30/04/2015	495.960
01/08/2011 - 31/08/2011	490.649	01/05/2015 - 31/05/2015	543.306
01/09/2011 - 30/09/2011	367.850	01/06/2015 - 30/06/2015	482.752
01/10/2011 - 31/10/2011	541.615	01/07/2015 - 31/07/2015	521.688
01/11/2011 - 30/11/2011	490.137	01/08/2015 - 31/08/2015	506.522
01/12/2011 - 31/12/2011	488.740	01/09/2015 - 30/09/2015	490.787
01/01/2012 - 31/01/2012	531.873	01/10/2015 - 31/10/2015	494.210
01/02/2012 - 29/02/2012	499.577	01/11/2015 - 30/11/2015	530.095
01/03/2012 - 31/03/2012	521.299	01/12/2015 - 31/12/2015	506.889
01/04/2012 - 30/04/2012	490.421	01/01/2016 - 31/01/2016	487.203

	01/05/2012 - 31/05/2012	545.092	01/02/2016 - 29/02/2016	502.355
	01/06/2012 - 30/06/2012	524.217	01/03/2016 - 31/03/2016	513.857
	01/07/2012 - 31/07/2012	528.132	01/04/2016 - 30/04/2016	482.545
	01/08/2012 - 31/08/2012	459.479	01/05/2016 - 31/05/2016	494.091
	01/09/2012 - 30/09/2012	537.778	01/06/2016 - 30/06/2016	505.156
	01/10/2012 - 31/10/2012	473.583	01/07/2016 - 31/07/2016	530.105
	01/11/2012 - 30/11/2012	511.676	01/08/2016 - 31/08/2016	461.353
	01/12/2012 - 31/12/2012	551.016	01/09/2016 - 30/09/2016	476.901
	01/01/2013 - 31/12/2013	0	01/10/2016 - 31/10/2016	537.607
	01/01/2014 - 31/01/2014	0	01/11/2016 - 30/11/2016	464.780
	01/02/2014 - 28/02/2014	0	01/12/2016 - 31/12/2016	521.331
	01/03/2014 - 31/03/2014	28.920	01/01/2017 - 31/01/2017	532.048
	01/04/2014 - 30/04/2014	519.235	01/02/2017 - 29/02/2017	436.740
	01/05/2014 - 31/05/2014	518.553	01/03/2017 - 31/03/2017	478.161
	01/06/2014 - 30/06/2014	539.840	01/04/2017 - 30/04/2017	495.830
	01/07/2014 - 31/07/2014	507.925	01/05/2017 - 31/05/2017	481.565
	01/08/2014 - 31/08/2014	540.737	01/06/2017 - 30/06/2017	520.460
	01/09/2014 - 30/09/2014	474.351	01/07/2017 - 31/07/2017	538.348
	01/10/2014 - 31/10/2014	540.648	01/08/2017 - 31/08/2017	523.920
	01/11/2014 - 30/11/2014	478.764	01/09/2017 - 30/09/2017	519.479
	01/12/2014 - 31/12/2014	520.769	01/10/2017 - 31/10/2017	493.097
	01/01/2015 - 31/01/2015	524.682	01/11/2017 - 18/11/2017	527.691
	01/02/2015 - 28/02/2015	544.326		
	01/03/2015 - 31/03/2015	578.507		

Monitoring equipment	Type	TBQ-15012 DN150
	Serial number	X6126013

		Accuracy class	2.0% for Q_{min}~0.2Q_{max}; 1.0% for 0.2Q_{max}~Q_{max}
		Calibration frequency	Every two years according to JJG 1037-2008
		Calibration date	28/09/2010 22/09/2012 18/09/2014 04/09/2016
		Validity	03/09/2018
QA/QC procedures to be applied	The flow meter was calibrated every two years according to national standard JJG 1037-2008. The calibration reports are kept by the project proponent.		
Purpose of the data	Calculation of baseline emissions		
Calculation method	-		
Comments	-		

Data / Parameter	Regulatory requirements relating to landfill gas projects
Data unit	%
Description	Regulatory requirements relating to landfill gas projects
Source of data	National legislation and mandatory regulations
Description of measurement methods and procedures to be applied	As per *Standard for pollution control on the landfill site of municipal solid waste* [6](GB 16889 - 2008), facilities which utilize or flare the landfill gas have to be installed at landfill sites with a landfill amount of more than 2.50 million tonnes and with a landfill height of more than 20 meters. According to *2019 China Urban-Rural Construction Statistical Yearbook* and *2020 Development Report on China's Biomass Power Industry*, as of 2019, there were 1,885 municipal landfill sites across the country, and only 216 gas-to-power projects were in operation[7]. It shows that the cited regulation in GB 16889 – 2008 was merely a recommendation instead of a mandatory requirement. The vast

[6] http://www.mee.gov.cn/ywgz/fgbz/bz/bzwb/gthw/gtfwwrkzbz/200804/W020120719581734247724.pdf

[7] http://www.tanpaifang.com/CCER/202106/1378174.html

	majority of the landfill sites vent directly methane into the atmosphere.
Frequency of monitoring/recording	-
Value monitored	0
Monitoring equipment	-
QA/QC procedures to be applied	Check enforced regulations in China
Purpose of the data	As per the registered PDD, the amount of regulatory requirements of methane destruction $MD_{reg,y}$ = 0 during the first commitment period.
Calculation method	-
Comments	-

Data / Parameter	Other flare operation parameters
Data unit	tCO_2e
Description	This should include all data and parameters required to be monitored whether the flare operators within the range of operating conditions are in accordance with the manufacturer's specifications
Source of data	Measured by project participants
Description of measurement methods and procedures to be applied	Measured and recorded by the project participants according to requirements of the methodology
Frequency of monitoring/recording	No further monitoring required for the flare system
Value monitored	-
Monitoring equipment	For the project, the flare efficiency is taken as a default value of 0%, which is conservative. Therefore, the other parameters required to monitor the accordance of the flare operation with the manufacturer's operation are not applicable.
QA/QC procedures to be applied	Meter shall be operated and maintained as per the specifications prescribed by the manufacturer.
Purpose of the data	-
Calculation method	-
Comments	-

4.3 Monitoring Plan

The monitoring plan details the actions necessary to record all the variables and factors required by the methodology ACM0001 (version 05), as detailed in the registered PDD.

Operation and management structure

To ensure the operation of the project, detailed responsibilities are set to each role according to the description of the registered PDD.

- General Manager: In charge of the overall operation and monitoring activities.
- CDM Project Manager: In charge of the on-site operation of the project to ensure the good operation of the plant.
- Plant Operational Manager: In charge of the daily monitoring and operation to ensure the accuracy of data recording.
- Financial Chief: In charge of electricity invoices and communication with local grid company.
- Technical Chief: In charge of management of monitored equipment.

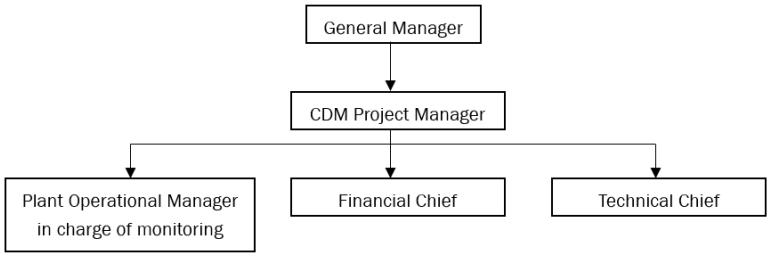

Figure 4.1 Organization of the monitoring team

Implementation of the monitoring

The monitoring focuses on the net electricity exported and the amount of methane destroyed.

The monitoring diagram stated in the registered PDD is shown in **Figure 4.2**.

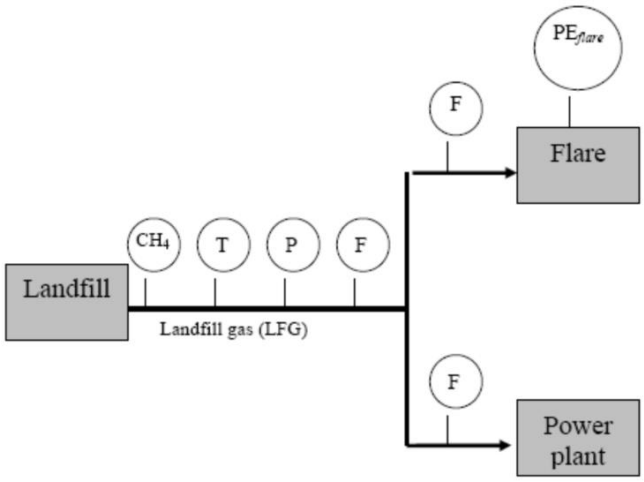

Figure 4.2 Monitoring equipment diagram in the registered PDD

The actual monitoring system during the reported monitoring period, illustrated in **Figure 4.3**, is consistent with the registered PDD. The flow rates of the three LFG streams (total LFG, LFG used for power generation and LFG destroyed by flaring) are measured by three flow meters, respectively. Likewise, the temperatures and the pressures of the three LFG streams are measured by thermometers and manometers, respectively. A gas analyzer measured the methane fraction in the LFG. **Table 4.1** shows the main information about the flow meters, thermometers, manometers and the gas analyzer. The amount of electricity exported to the grid and the amount of electricity imported from the grid are measured by a bi-directional meter, whose readings are recorded every day. The metering equipment used for monitoring is calibrated and checked for accuracy, the frequency of which strictly follows the national calibration standards.

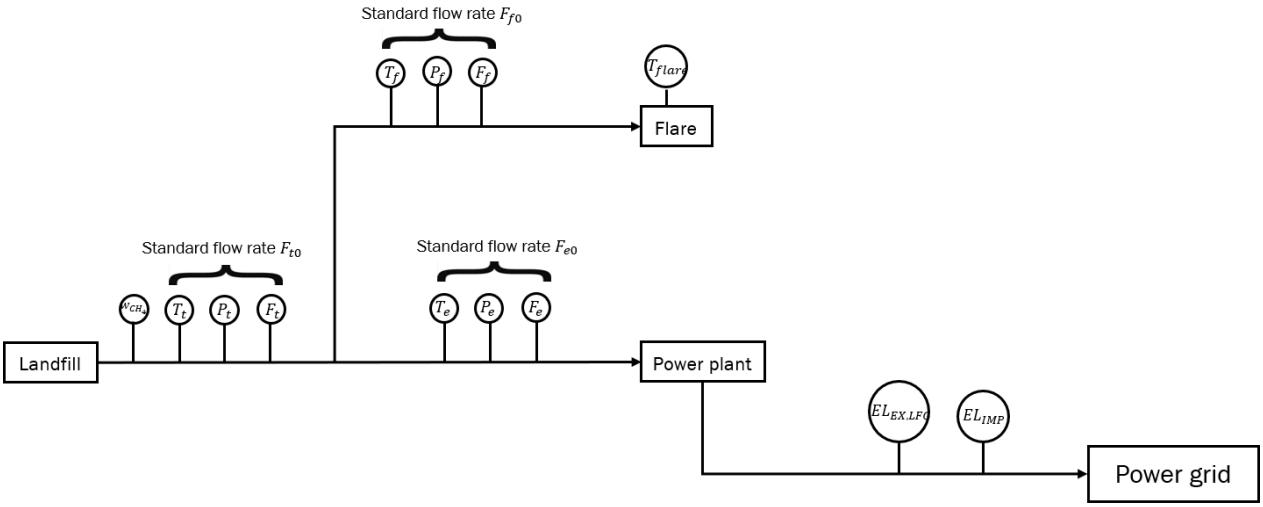

Figure 4.3 Monitoring equipment diagram during the reported monitoring period

Measurements:

w_{CH_4}= Volume fraction of methane in the landfill gas

T_t, T_e, T_f = Temperatures of three LFG streams, corresponding to *Degree* in Section 4.2

P_t, P_e, P_f = Pressures of three LFG streams, corresponding to *P* in Section 4.2

F_t, F_e, F_f = Flow rates of three LFG streams measured by the flow meters

F_{t0}, F_{e0}, F_{f0}= Standard flow rates (calculated using the parameters above)

Table 4.1 Main information of the monitoring equipment

	Flow meter	Manometer	Thermometer	Gas analyzer
Manufacturer	Zhejiang Tianxing Instrument Co., Ltd.	Shanghai Suotu Electronic Co., Ltd	Shanghai Suotu Electronic Co., Ltd	Dragerwerk AG & Co. KGaA
Reading frequency	Continuously monitored by the computer system	Continuously monitored by the computer system	Continuously monitored by the computer system	Continuously monitored by the computer system
Calibration standard	JJG 1037-2008	JJG 882-2004	JJG 1183-2007	Product Manual

QA/QC procedure

To ensure the accuracy of the data recording and the monitoring, the procedure below is implemented during the monitoring period.

1) An agreement on measurement arrangement and quality control process has been signed between the project proponent and the electricity grid company. The electricity grid company verifies the electricity quantity and provides the records to the project proponent. The records are archived by the project proponent.

2) The on-site monitoring staff is divided into 2 teams working on two shifts in 24 hours and taking charge of the plant operation management and data collection. Each team has 7 staff members, 2 in the central operation room and 5 in the landfill site. In the evening, no staff member is allowed to enter the landfill site. Staff members take classes before being allowed to work in the project. The training records are kept by the project proponent.

3) The data is recorded both by the monitoring staff and the computer system. And the data recorded by the staff is checked by the team leader to ensure the accuracy before the data is submitted to the manager. And the two sets of data are cross checked to ensure the accuracy.

4) The operation and management of the equipment in the project is supported by technical experts from equipment suppliers to ensure that all equipment is in good conditions.

5) The project proponent sends related equipment for calibrations on a regular basis according to the national standards and keeps copies of all the calibration reports. And project proponent prepares backup procedures to deal with any errors occurred to the meters.

5 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

5.1 Baseline Emissions

As per ACM0001 (version 05), the emission reductions are calculated as follows:

$$ER_y = \left(MD_{project,y} - MD_{reg,y}\right) \times GWP_{CH_4} + EL_y \times CEF_{electricity,y} - ET_y \times CEF_{thermal,y}$$

Equation (1)

where:

ER_y	=	Emission reductions, in tons of CO_2 equivalents (tCO_2e).
$MD_{project,y}$	=	Amount of methane that would have been destroyed/combusted during the year *y* (tCH_4).
$MD_{reg,y}$	=	Amount of methane that would have been destroyed/combusted during the year *y* in the absence of the project activity (tCH_4). Its value is 0 according to the registered PDD.
GWP_{CH_4}	=	Global Warming Potential value for methane. As per *VCS Standard v4.1*, projects that complete validation on or before 31 July 2021 shall use GWP values from *IPCC Fifth Assessment Report* (AR5) for ex-post calculations. According to AR5, the 100-year GWP value of methane is 28 tCO_2e/CH_4.
EL_y	=	Net quantity of electricity exported during the year *y* (MWh).
$CEF_{electricity,y}$	=	CO_2 emission intensity of the electricity displaced (tCO_2e/MWh). Its value has been calculated in the registered PDD, according to which, it is 0.8541 tCO_2e/MWh.

ET_y	=	Incremental quantity of fossil fuel, defined as difference of fossil fuel used in the baseline and fossil fuel used in the project, for energy requirement on site under project activity during the year *y* (TJ).
$CEF_{electricity,y}$	=	CO_2 emission intensity of the fuel used to generate thermal/mechanical energy (tCO_2e/TJ).

$MD_{project,y}$, the amount of methane that would have been destroyed/combusted during the year *y*, is calculated as follows:

$$MD_{project,y} = MD_{flare,y} + MD_{electricity,y} + MD_{thermal,y} \quad \text{Equation (2)}$$

where:

$MD_{flared,y}$	=	Amount of methane destroyed by flaring during the year *y* (tCH_4).
$MD_{electricity,y}$	=	Amount of methane destroyed for power generation during the year *y* (tCH_4).
$MD_{thermal,y}$	=	Amount of methane destroyed for heat generation the year *y* (tCH_4). The project activity does not involve heat generation. $MD_{thermal,y}$= 0.

$MD_{electricity,y}$, the amount of methane destroyed for power generation during the year *y*, is calculated as follows:

$$MD_{electricity,y} = LFG_{electricity,y} \times w_{CH_4,y} \times D_{CH_4} \quad \text{Equation (3)}$$

where:

$LFG_{electricity,y}$	=	Amount of landfill gas destroyed in power plant during the year *y* (m^3LFG).
$w_{CH_4,y}$	=	Average methane fraction of the landfill gas as measured during the year *y* (m^3CH_4 / m^3LFG).
D_{CH_4}	=	Methane density (tCH_4/m^3CH_4). Its value is 0.0007168.

$MD_{flare,y}$, the amount of methane destroyed by flaring during the year *y*, is calculated as follows:

$$MD_{flare,y} = \left(LFG_{flare,y} \times w_{CH_4,y} \times D_{CH_4}\right) - \left(PE_{flare,y}/GWP_{CH_4}\right) \quad \text{Equation (4)}$$

where:

$LFG_{flare,y}$ = Amount of landfill gas destroyed by flaring during the year *y* (m^3LFG).

$PE_{flare,y}$ = Project emissions due to the flaring of the residual gas stream in year *y* (tCO_2e). The value should be calculated following the procedure describe in "Tool to determine project emissions from flaring gases containing methane to calculate the project emissions" (Version 1).

$PE_{flare,y}$, the project emissions due to the flaring of the residual gas stream in year *y* (tCO_2e), is calculated as follows:

$$PE_{flare,y} = \sum TM_{RG,h} \times (1 - \eta_{flare,h}) \times \frac{GWP_{CH_4}}{1000} \quad \text{Equation (5)}$$

where:

$TM_{RG,h}$ = Mass flow rate of methane in the residual gas in hour *h* (kg/h).

$\eta_{flare,h}$ = Flare efficiency in hour *h*

The project adopts enclosed flares and uses the default value for the flare efficiency. As per "Tool to determine project emissions from flaring gases containing methane to calculate the project emissions" (Version 1), the value of $\eta_{flare,h}$ is:

- 0% if the temperature in the exhaust gas of the flare (T_{flare}) is below 500°C for more than 20 minutes during the hour *h*;
- 50% if the temperature in the exhaust gas of the flare (T_{flare}) is above 500°C for more than 40 minutes during the hour *h* but the manufacturer's specifications on proper operation of the flare are not met continuously during the hour *h*;
- 90% if the temperature in the exhaust gas of the flare (T_{flare}) is above 500°C for more than 40 minutes during the hour *h* and the manufacturer's specifications on proper operation of the flare are met continuously during the hour *h*.

The methane mass flow rate in the residual gas flowing into the flare is calculated as follows:

$$TM_{RG,h} = FV_{RG,h} \times fv_{CH_4,RG,h} \times D_{CH_4} \quad \text{Equation (6)}$$

where:

$FV_{RG,h}$ = Volumetric flow rate of the residual gas on dry basis at normal conditions in hour *h* (m^3/h).

$fv_{CH_4,RG,h}$ = Volumetric fraction of methane in the residual gas on dry basis in hour *h*.

D_{CH_4} = Methane density. Its value is 0.0007168 tCH_4/m^3CH_4 or 0.7168 $kgCH_4/m^3CH_4$)

EL_y, net quantity of electricity exported during the year *y* (MWh) is calculated as follows:

$$EL_y = EL_{EX,LGF} - EL_{IMP} \quad \text{Equation (7)}$$

where:

$EL_{EX,LGF}$ = Quantity of electricity exported during the year *y*, produced using landfill gas (MWh).

EL_{IMP} = Quantity of electricity imported, defined as the difference of project imports less any imports of electricity in the baseline, to meet the project requirements (MWh).

The measured LFG data are presented in **Table 5.1**. of section 5.4. The electricity generation data are presented in **Table 5.2** of section 5.4.

5.2 Project Emissions

As no other fuels are used within the project boundary, the project emissions are zero: PE_y = 0.

5.3 Leakage

As per ACM0001 (version 05), no leakage effects need to be accounted. Therefore, L_y = 0.

5.4 Net GHG Emission Reductions and Removals

As no additional fossil fuel was used during the monitoring period, the emission reductions for the project during the crediting period was calculated by applying Equation (8).

$$ER_y = MD_{project,y} \times GWP_{CH4} + EG_y \times CEF_{electricity} \quad \text{Equation (8)}$$

Therefore, ER_y= 7,386.631 × 28 + 29,366 × 0.8541 = 231,904 tCO_2e

The measured LFG data are presented in **Table 5.1**. The electricity generation data are presented in **Table 5.2**. The emission reductions are presented in **Table 5.3**.

Table 5.1 LFG data from 01/07/2011 to 18/11/2017

Period	$LFG_{total,y}$ [8] [9]	$LFG_{electricity,y}$ [9]	$LFG_{flare,y}$ [9]	$w_{CH4,y}$	$MD_{electricity,y}$	η_{flare}	$MD_{flare,y}$	$MD_{project,y}$
	m^3	m^3	m^3	m^3CH_4/m^3LFG	tCH_4	%	tCH_4	tCH_4
01/07/2011 - 31/07/2011	427,146.493	426,285.507	860.735	43.39%	132.583	0	0	132.583
01/08/2011 - 31/08/2011	400,211.101	398,835.981	1,373.816	47.34%	135.338	0	0	135.338
01/09/2011 - 30/09/2011	331,678.894	331,605.720	73.570	48.66%	115.662	0	0	115.662
01/10/2011 - 31/10/2011	437,973.531	434,831.732	3,141.368	40.58%	126.483	0	0	126.483
01/11/2011 - 30/11/2011	378,368.400	376,064.357	2,303.642	43.79%	118.042	0	0	118.042
01/12/2011 - 31/12/2011	292,373.635	289,880.281	2,492.575	46.91%	97.472	0	0	97.472
Subtotal 01/07/2011 - 31/12/2011	**2,267,752.054**	**2,257,503.578**	**10,245.706**		**725.581**	**0**	**0**	**725.581**
01/01/2012 - 31/01/2012	353,326.897	350,985.501	2,340.239	44.75%	112.585	0	0	112.585
01/02/2012 - 29/02/2012	406,029.263	405,879.836	149.873	39.19%	114.017	0	0	114.017
01/03/2012 - 31/03/2012	238,395.694	236,414.275	1,980.936	47.11%	79.833	0	0	79.833
01/04/2012 - 30/04/2012	223,609.224	221,450.854	2,157.854	41.45%	65.796	0	0	65.796
01/05/2012 - 31/05/2012	184,354.724	182,229.203	2,125.857	48.64%	63.534	0	0	63.534
01/06/2012 - 30/06/2012	205,365.413	203,111.249	2,254.132	40.89%	59.532	0	0	59.532
01/07/2012 - 31/07/2012	157,767.148	156,024.578	1,742.834	45.11%	50.45	0	0	50.45
01/08/2012 - 31/08/2012	83,538.811	83,125.244	413.531	41.38%	24.656	0	0	24.656
01/09/2012 - 30/09/2012	123,222.778	122,630.988	591.556	43.08%	37.868	0	0	37.868
01/10/2012 - 31/10/2012	100,541.112	100,209.786	331.508	41.08%	29.508	0	0	29.508

[8] The value of $LFG_{total,y}$ is slightly higher or lower than the sum of $LFG_{electricity,y}$ and $LFG_{flare,y}$, and this is due to stochastic errors which are negligible and within the accuracy range of the measuring equipment.

[9] The values of $LFG_{total,y}$, $LFG_{electricity,y}$, $LFG_{flare,y}$ have been automatically converted to standard condition (0℃, 1 atm) values by the computer system which collects the data of flow (noted as $F_{measured}$), temperature (noted as $T_{measured}$) and pressure (noted as $P_{measured}$) and calculates the flow under the standard condition using the equation of "ideal gas law": $PV=nRT$.

$P_{measured} \cdot V_{measured} = n \cdot R \cdot T_{measured}$

$P_{standard} \cdot V_{standard} = n \cdot R \cdot T_{standard}$

$V_{standard} = (V_{measured} \cdot T_{standard} \cdot P_{measured})/(P_{standard} \cdot T_{measured})$, with $T_{standard}$ = 273.15 K and $P_{measured}$ = 1 atm = 101.325 kPa and $T_{measured}$ converted to kelvin temperature: $T_{measured}$ (in K) = $T_{measured}$ (in ℃) + 273.15.

For each of the three streams, the measured flow, temperature and pressure are collected every minute by the computer which instantly converts the data into standard condition flow using the procedure described above. The monthly flows presented in the table are accumulated values over the month.

01/11/2012 - 30/11/2012	94,730.663	93,809.467	921.017	47.78%	32.129	0	0	32.129
01/12/2012 - 31/12/2012	59,195.773	58,755.038	440.813	48.10%	20.258	0	0	20.258
Subtotal 01/01/2012 - 31/12/2012	**2,230,077.500**	**2,214,626.019**	**15,450.150**		**690.166**	**0**	**0**	**690.166**
01/01/2013 - 31/12/2013	0[10]	0	0	0	0	0	0	0
Subtotal 01/01/2013 - 31/12/2013	**0**	**0**	**0**		**0**	**0**	**0**	**0**
01/01/2014 - 31/01/2014	0	0	0	0	0	0	0	0
01/02/2014 - 28/02/2014	0	0	0	0	0	0	0	0
01/03/2014 - 31/03/2014	328.249	325.369	2.880	45.17%	0.106	0	0	0.106
01/04/2014 - 30/04/2014	122,458.356	121,475.983	982.107	41.95%	36.693	0	0	36.693
01/05/2014 - 31/05/2014	122,434.967	121,505.385	929.195	42.26%	36.973	0	0	36.973
01/06/2014 - 30/06/2014	329,080.377	328,758.126	322.446	41.55%	98.357	0	0	98.357
01/07/2014 - 31/07/2014	236,367.837	234,952.406	1,415.789	40.01%	67.687	0	0	67.687
01/08/2014 - 31/08/2014	305,256.382	304,072.310	1,184.269	39.23%	85.892	0	0	85.892
01/09/2014 - 30/09/2014	242,588.461	240,698.709	1,888.867	39.87%	69.1	0	0	69.1
01/10/2014 - 31/10/2014	365,704.610	362,904.926	2,798.716	48.41%	126.498	0	0	126.498
01/11/2014 - 30/11/2014	328,940.323	328,319.611	619.592	44.39%	104.939	0	0	104.939
01/12/2014 - 31/12/2014	377,669.606	374,093.044	3,577.134	47.70%	128.486	0	0	128.486
Subtotal [11] 01/01/2014 - 31/12/2014	**2,430,829.170**	**2,417,105.869**	**13,720.994**		**751.334**	**0**	**0**	**751.334**
01/01/2015 - 31/01/2015	250,849.658	247,963.905	2,885.751	43.56%	77.424	0	0	77.424
01/02/2015 - 28/02/2015	291,584.365	289,624.994	1,959.572	46.69%	96.93	0	0	96.93
01/03/2015 - 31/03/2015	324,109.275	323,935.093	173.552	42.85%	99.496	0	0	99.496

[10] The 1# generator was switched on and operated for a short timeslot from 4 a.m. to 5 a.m. 15/10/2013, producing a small amount of electricity. A small amount of LFG was also consumed. However, for conservativeness, the amount of LFG consumed throughout 2013 is neglected.

[11] The thermometers and the manometers were out of calibration during part of the year 2014. Precisely speaking, the thermometers were out of calibration from 31/03/2014 to 25/11/2014, and the manometers from 31/03/2014 to 03/12/2014. Therefore, to make sure that the ER calculation is conservative, the following measure is taken for the period from 31/03/2014 to 31/12/2014:

As discussed in Note 9 of page 40, the volume under the standard condition has been calculated based on measured volume, temperature and pressure: $V_{standard} = (V_{measured} \cdot T_{standard} \cdot P_{measured})/(P_{standard} \cdot T_{measured})$. The margins of error of the thermometers and the manometers are ±0.25% and ±0.2%, respectively. For conservativeness, the corrected volume should be calculated based on (1−0.2%) of $P_{measured}$ and (1+0.25%) of $T_{measured}$, which means:

$$V_{standard,conserv} = (V_{measured} \cdot T_{standard} \cdot P_{measured} \cdot (1-0.2\%))/(P_{standard} \cdot T_{measured} \cdot (1+0.25\%)) = 0.9955 \cdot V_{standard}.$$

01/04/2015 - 30/04/2015	531,658.423	530,566.921	1,091.111	40.02%	152.2	0	0	152.2
01/05/2015 - 31/05/2015	526,838.519	521,895.411	4,944.083	42.66%	159.575	0	0	159.575
01/06/2015 - 30/06/2015	363,596.227	361,278.681	2,317.209	46.68%	120.885	0	0	120.885
01/07/2015 - 31/07/2015	508,073.332	502,176.971	5,895.080	43.17%	155.395	0	0	155.395
01/08/2015 - 31/08/2015	315,725.352	313,547.789	2,178.044	40.09%	90.103	0	0	90.103
01/09/2015 - 30/09/2015	360,915.151	360,031.090	883.417	39.75%	102.583	0	0	102.583
01/10/2015 - 31/10/2015	345,576.972	342,511.918	3,064.104	46.04%	113.034	0	0	113.034
01/11/2015 - 30/11/2015	338,213.186	334,715.127	3,498.626	40.61%	97.433	0	0	97.433
01/12/2015 - 31/12/2015	375,645.852	373,668.865	1,976.867	45.70%	122.406	0	0	122.406
Subtotal 01/01/2015 - 31/12/2015	**4,532,786.312**	**4,501,916.765**	**30,867.416**		**1,387.477**	**0**	**0**	**1,387.477**
01/01/2016 - 31/01/2016	448,507.371	448,311.193	194.881	44.80%	143.965	0	0	143.965
01/02/2016 - 28/02/2016	387,375.483	383,405.379	3,968.601	40.44%	111.139	0	0	111.139
01/03/2016 - 31/03/2016	482,718.661	479,068.375	3,648.387	46.87%	160.95	0	0	160.95
01/04/2016 - 30/04/2016	484,040.647	481,580.140	2,460.981	44.95%	155.166	0	0	155.166
01/05/2016 - 31/05/2016	507,388.648	502,546.634	4,842.090	46.12%	166.136	0	0	166.136
01/06/2016 - 30/06/2016	421,842.284	419,719.311	2,121.655	48.44%	145.734	0	0	145.734
01/07/2016 - 31/07/2016	327,063.894	324,201.868	2,862.568	42.10%	97.835	0	0	97.835
01/08/2016 - 31/08/2016	649,895.818	648,647.647	1,245.652	43.28%	201.231	0	0	201.231
01/09/2016 - 30/09/2016	602,361.187	598,591.405	3,767.520	39.77%	170.641	0	0	170.641
01/10/2016 - 31/10/2016	752,917.311	746,303.367	6,612.561	39.31%	210.289	0	0	210.289
01/11/2016 - 30/11/2016	605,571.136	602,641.046	2,928.111	44.93%	194.086	0	0	194.086
01/12/2016 - 31/12/2016	715,734.989	707,861.189	7,872.101	46.68%	236.852	0	0	236.852
Subtotal 01/01/2016 - 31/12/2016	**6,385,417.429**	**6,342,877.554**	**42,525.108**		**1,994.023**	**0**	**0**	**1,994.023**
01/01/2017 - 31/01/2017	493,271.883	491,037.766	2,234.602	39.27%	138.221	0	0	138.221
01/02/2017 - 28/02/2017	476,744.695	476,612.643	131.022	44.33%	151.447	0	0	151.447
01/03/2017 - 31/03/2017	706,544.742	704,537.319	2,008.275	40.77%	205.894	0	0	205.894
01/04/2017 - 30/04/2017	675,449.986	674,258.252	1,189.991	45.99%	222.273	0	0	222.273
01/05/2017 - 31/05/2017	699,644.450	693,862.934	5,778.783	46.12%	229.383	0	0	229.383
01/06/2017 - 30/06/2017	541,929.031	539,223.534	2,706.391	45.81%	177.063	0	0	177.063

01/07/2017 - 31/07/2017	602,703.096	602,055.152	646.018	39.65%	171.111	0	0	171.111
01/08/2017 - 31/08/2017	432,126.630	428,721.013	3,405.481	42.67%	131.128	0	0	131.128
01/09/2017 - 30/09/2017	511,699.634	508,580.799	3,116.876	45.78%	166.891	0	0	166.891
01/10/2017 - 31/10/2017	630,697.138	629,956.778	739.646	44.91%	202.792	0	0	202.792
01/11/2017 - 18/11/2017	140,345.714	138,867.925	1,477.535	42.04%	41.847	0	0	41.847
Subtotal 01/01/2017 - 18/11/2017	**5,911,156.999**	**5,887,714.115**	**23,434.620**		**1,838.050**	**0**	**0**	**1,838.050**
Total 01/07/2011 - 18/11/2017	**23,758,019.464**	**23,621,743.900**	**136,243.995**		**7,386,631**	**0**	**0**	**7,386.631**

Table 5.2 Electricity generation data from 01/07/2011 to 18/11/2017

Period	$EL_{EX,LFG}$			EL_{IMP}			EL_y
	Meter value MWh	Sales invoices MWh	Conservative MWh	Meter value MWh	Purchase invoices MWh	Conservative MWh	MWh
01/07/2011 - 31/07/2011	573.090	581.167	573.090	0.452	0.000	0.452	572.638
01/08/2011 - 31/08/2011	525.838	504.053	504.053	0.935	0.000	0.935	503.118
01/09/2011 - 30/09/2011	478.137	496.601	478.137	0.241	0.299	0.299	477.838
01/10/2011 - 31/10/2011	496.047	469.595	469.595	0.241	0.000	0.241	469.354
01/11/2011 - 30/11/2011	485.749	531.059	485.749	0.090	0.000	0.090	485.659
01/12/2011 - 31/12/2011	450.019	457.195	450.019	0.392	0.000	0.392	449.627
Subtotal 01/07/2011 - 31/12/2011			**2,960.643**			**2.410**	**2,958.234**
01/01/2012 - 31/01/2012	477.451	391.049	391.049	0.181	0.450	0.450	390.599
01/02/2012 - 29/02/2012	330.171	440.560	330.171	1.176	1.170	1.176	328.995
01/03/2012 - 31/03/2012	336.780	324.447	324.447	0.720	0.750	0.750	323.697
01/04/2012 - 30/04/2012	342.570	348.427	342.570	0.180	0.180	0.180	342.390
01/05/2012 - 31/05/2012	214.590	217.312	214.590	3.570	3.570	3.570	211.020
01/06/2012 - 30/06/2012	239.400	305.478	239.400	1.890	1.020	1.890	237.510
01/07/2012 - 31/07/2012	178.200	163.238	163.238	6.150	5.880	6.150	157.088
01/08/2012 - 31/08/2012	128.640	121.809	121.809	9.720	10.410	10.410	111.399
01/09/2012 - 30/09/2012	164.220	170.784	164.220	5.940	6.000	6.000	158.220
01/10/2012 - 31/10/2012	123.300	120.229	120.229	8.550	8.070	8.550	111.679

01/11/2012 - 30/11/2012	148.320	147.519	147.519	6.420	7.050	7.050	140.469
01/12/2012 - 31/12/2012	69.450	83.841	69.450	8.850	6.160	8.850	60.600
Subtotal 01/01/2012 - 31/12/2012			**2,628.692**			**55.026**	**2,573.666**
01/01/2013 - 31/12/2013	5.224	5.220	5.220	78.210	61.590	78.210	-72.990
Subtotal 01/01/2013 - 31/12/2013			**5.220**			**78.210**	**-72.990**
01/01/2014 - 31/01/2014	0.000	0.000	0.000	3.878	5.820	5.820	-5.820
01/02/2014 - 28/02/2014	0.000	0.000	0.000	5.332	6.600	6.600	-6.600
01/03/2014 - 31/03/2014	0.450	0.447	0.447	2.908	6.330	6.330	-5.883
01/04/2014 - 30/04/2014	163.170	162.224	162.224	4.362	5.520	5.520	156.704
01/05/2014 - 31/05/2014	184.740	160.643	160.643	7.755	6.030	7.755	152.888
01/06/2014 - 30/06/2014	435.120	382.518	382.518	3.878	1.890	3.878	378.640
01/07/2014 - 31/07/2014	360.870	378.343	360.870	5.817	0.090	5.817	355.053
01/08/2014 - 31/08/2014	395.130	333.693	333.693	2.520	0.000	2.520	331.173
01/09/2014 - 30/09/2014	340.680	407.155	340.680	3.870	0.000	3.870	336.810
01/10/2014 - 31/10/2014	442.620	388.842	388.842	0.540	0.000	0.540	388.302
01/11/2014 - 30/11/2014	441.840	452.341	441.840	0.390	0.000	0.390	441.450
01/12/2014 - 31/12/2014	432.630	425.647	425.647	0.180	0.000	0.180	425.467
Subtotal 01/01/2014 - 31/12/2014			**2,997.404**			**49.220**	**2,948.184**
01/01/2015 - 31/01/2015	364.320	348.219	348.219	0.300	0.330	0.330	347.889
01/02/2015 - 28/02/2015	352.320	392.093	352.320	1.500	1.500	1.500	350.820
01/03/2015 - 31/03/2015	465.720	440.649	440.649	0.630	0.030	0.630	440.019
01/04/2015 - 30/04/2015	601.290	484.464	484.464	0.090	0.660	0.660	483.804
01/05/2015 - 31/05/2015	748.560	812.788	748.560	1.560	0.660	1.560	747.000
01/06/2015 - 30/06/2015	522.270	483.509	483.509	2.220	3.150	3.150	480.359
01/07/2015 - 31/07/2015	696.810	703.923	696.810	0.210	0.180	0.210	696.600
01/08/2015 - 31/08/2015	481.440	516.288	481.440	1.350	1.410	1.410	480.030
01/09/2015 - 30/09/2015	445.860	475.277	445.860	0.750	0.000	0.750	445.110
01/10/2015 - 31/10/2015	501.330	464.928	464.928	0.300	0.000	0.300	464.628
01/11/2015 - 30/11/2015	513.750	525.922	513.750	0.090	0.090	0.090	513.660

01/12/2015 - 31/12/2015	505.740	485.150	485.150	0.600	0.600	0.600	484.550
Subtotal 01/01/2015 - 31/12/2015			**5,945.659**			**11.190**	**5,934.469**
01/01/2016 - 31/01/2016	557.760	536.510	536.510	0.570	0.510	0.570	535.940
01/02/2016 - 28/02/2016	581.070	618.800	581.070	0.180	0.240	0.240	580.830
01/03/2016 - 31/03/2016	587.280	551.453	551.453	0.180	0.090	0.180	551.273
01/04/2016 - 30/04/2016	597.210	576.298	576.298	0.150	0.240	0.240	576.058
01/05/2016 - 31/05/2016	713.940	693.842	693.842	0.600	0.600	0.600	693.242
01/06/2016 - 30/06/2016	511.620	589.660	511.620	1.350	1.140	1.350	510.270
01/07/2016 - 31/07/2016	479.040	395.612	395.612	1.290	1.500	1.500	394.112
01/08/2016 - 31/08/2016	821.190	786.452	786.452	0.210	0.240	0.240	786.212
01/09/2016 - 30/09/2016	707.760	832.384	707.760	0.360	0.030	0.360	707.400
01/10/2016 - 31/10/2016	847.830	718.359	718.359	0.030	0.360	0.360	717.999
01/11/2016 - 30/11/2016	743.400	751.287	743.400	0.000	0.000	0.000	743.400
01/12/2016 - 31/12/2016	823.440	831.728	823.440	0.210	0.120	0.210	823.230
Subtotal 01/01/2016 - 31/12/2016			**7.625.816**			**5.850**	**7,619.966**
01/01/2017 - 31/01/2017	738.210	636.368	636.368	0.270	0.360	0.360	636.008
01/02/2017 - 28/02/2017	700.020	860.450	700.020	0.360	0.000	0.360	699.660
01/03/2017 - 31/03/2017	846.060	750.243	750.243	0.060	0.300	0.300	749.943
01/04/2017 - 30/04/2017	782.550	783.082	782.550	0.030	0.030	0.030	782.520
01/05/2017 - 31/05/2017	853.440	881.686	853.440	0.090	0.060	0.090	853.350
01/06/2017 - 30/06/2017	657.390	643.108	643.108	0.240	0.270	0.270	642.838
01/07/2017 - 31/07/2017	846.990	822.303	822.303	0.060	0.030	0.060	822.243
01/08/2017 - 31/08/2017	520.020	547.128	520.020	0.270	0.300	0.300	519.720
01/09/2017 - 30/09/2017	704.400	701.508	701.508	0.390	0.390	0.390	701.118
01/10/2017 - 31/10/2017	873.030	825.703	825.703	0.030	0.000	0.030	825.673
01/11/2017 - 18/11/2017	172.860	265.178	172.860	0.810	0.000	0.810	172.050
Subtotal 01/01/2017 - 18/11/2017			**7,408.123**			**3.120**	**7,405.003**
Total 01/07/2011 - 18/11/2017			**29,571.557**			**205.025**	**29,366.532**

Table 5.3 Net GHG emission reductions from 01/07/2011 to 18/11/2017

Period	Baseline emissions or removals (tCO_2e)	Project emissions or removals (tCO_2e)	Leakage emissions (tCO_2e)	Net GHG emission reductions or removals (tCO_2e)
01/07/2011 – 31/12/2011	22,842	0	0	22,842
01/01/2012 – 31/12/2012	21,522	0	0	21,522
01/01/2013 – 31/12/2013	0	0	0	0[12]
01/01/2014 – 31/12/2014	23,493	0	0	23,493
01/01/2015 – 31/12/2015	43,917	0	0	43,917
01/01/2016 – 31/12/2016	62,340	0	0	62,340
01/01/2017 – 18/11/2017	57,790	0	0	57,790
Total 01/07/2011 – 18/11/2017	231,904	0	0	231,904

Table 5.4 Comparison between the actual and estimated emission reductions

	Values based on the registered CDM-PDD	Actual values reached during the monitoring period
Emission reductions (tCO_2e)	881,516	231,904

[12] When calculating the emission reductions separately for the year 2013 and the year 2014, the emission reductions achieved in 2013 would have been -62, while the emission reductions in 2014 would have been 23,555 (refer to the ER spreadsheet for details). To avoid the negative value in 2013, the emission reductions in that year are modified to 0, and integrated into the year 2014, reducing the emission reductions in that year to 23,493.

A comparison between the actual emission reductions achieved during the monitoring period and the estimations in the registered CDM-PDD has been made. For the 2,333 days of the reported monitoring period, the emission reductions are 231,904 tCO_2e. The estimated annual emission reductions (365 days) in the PDD are 137,914 tCO_2e, which means that the estimated value for 2,333 days should have been 881,516 tCO_2e[13], as presented in **Table 5.4**.

The actual emission reductions were 73.7% lower than the estimated value[14], and this was due to three reasons: 1) a shut-down of the project lasted for more than a year during the reported monitoring period; 2) the project initially planned to install three gas engines with a total capacity of 2.5 MW, but in reality only two engines with a total capacity of 1.668 MW were installed; 3) the actual productivity of LFG from the landfill was much lower than what was estimated in the registered PDD. The three reasons are carefully elaborated below.

The first reason mentioned above was the 16-month shut-down. If the shut-down period were excluded from the monitoring period, the duration of the monitoring period would have covered 1,865 days[15], and the emission reductions would have been 704,683 tCO_2e[16] based on the PDD estimation. The actual emission reductions were 67.1% lower[17] than that value, mainly because of the actual capacity installed as well as the low productivity of the LFG from the landfill. The actual emission reductions achieved during the previous CDM monitoring periods 17/11/2008 to 31/05/2009 [18], 01/06/2009 to 30/06/2010 [19] and 01/07/2010 to 30/06/2011 [20] were 67%, 65% and 70%, respectively, lower than the registered PDD estimation. Compared with the previous data, the actual emission reductions during the reported monitoring period are consistent and reasonable. However, the shut-down does not fully explain the 67.1% gap, which is attributed to the two other reasons.

The registered PDD estimated the ex ante emission reductions 137,914 tCO_2e per year based on the planned capacity of 2.5 MW. It is reasonable to assume that the estimated emission reductions in the registered PDD would have been 92,016 tCO_2e [21] if the capacity was 1.668 MW. Based on 92,016 tCO_2e (365 days), the emission reductions for 1,865 days would have been

[13] (137,914/365) × 2,333 = 881,516.

[14] 231,904 / 881,516 – 1 = -73.7%.

[15] By excluding the shut-down period 19/12/2012 to 31/03/2014 (468 days) from 2,333 days: 2,333 – 468 = 1,865 days.

[16] (137,914/365) × 1,865 = 704,683.

[17] 231,904/704,683 – 1 = -67.1%.

[18] https://cdm.unfccc.int/Projects/DB/DNV-CUK1204757435.62/iProcess/JQA1253254959.18/view

[19] https://cdm.unfccc.int/Projects/DB/DNV-CUK1204757435.62/iProcess/JQA1298592774.98/view

[20] https://cdm.unfccc.int/Projects/DB/DNV-CUK1204757435.62/iProcess/JQA1319177623.9/view

[21] (137,914/2.5) × 1.668 = 92,016.

470,163 tCO_2e [22]. The actual emission reductions achieved during the reported monitoring period are still 50.7% lower[23] than that value, and this is due to the third reason: the actual productivity of LFG from the landfill was much lower than the registered PDD estimation.

[22] (92,016/365) × 1,865 = 470,163.

[23] 231,904 / 470,163 – 1 = -50.7%