Monitoring report form for CDM project activity
(Version 06.0)

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

MONITORING REPORT		
Title of the project activity	Shenyang Laohuchong LFG Power Generation Project	
UNFCCC reference number of the project activity	1906	
Version number of the PDD applicable to this monitoring report	03	
Version number of this monitoring report	02	
Completion date of this monitoring report	03/03/2018	
Monitoring period number	Sixth monitoring period	
Duration of this monitoring period	01/01/2017-31/12/2017(both days included)	
Monitoring report number for this monitoring report	-	
Project participants	Shenyang Laohuchong Municipal Solid Waste Management Co. Ltd. Asja Ambiente Italia S.p.A. ICF - International Clean Fund LLC	
Host Party	People's Republic of China	
Sectoral scopes	1-Energy industry(renewable and non-renewable sources);13-waste handling and disposal	
Applied methodologies and standardized baselines	ACM0001(Version 06) ; ACM0002(Version 06) ;	
Amount of GHG emission reductions or net anthropogenic GHG removals achieved by the project activity in this monitoring period	Amount achieved before 1 January 2013	Amount achieved from 1 January 2013
	0	147,497
Amount of GHG emission reductions or net anthropogenic GHG removals estimated ex ante for this monitoring period in the PDD	167,687	

SECTION A. Description of project activity

A.1. General description of project activity

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1. The purpose of the project capturing and burning biogas, generating electricity, at the Shenyang Laohuchong Municipal Solid Waste Landfill.
   The greenhouse gas emissions reduction is realized through the destruction of methane contained in the biogas arising from the landfill which is fed into both electricity generation system and high temperature flare, and by avoiding consumptions of fossil fuel which should have been used to generated electricity (according to the local Grid Emission Factor) substituted by the electricity generated in the biogas plant (renewable source) during a crediting period of 10 years.
2. The process includes LFG collecting, pre-treatment, power generation and flare combustion systems. The power plant is connected to local grid (North East Electric Power Grid) through transformer substation system. The whole process is managed by an electrical control system which is provided with a PLC (Programmable Logical Controller). All measured process signals are processed by the PLC to output signals for the gas-coolers, blower and flares.
3. The project is designed to have at its final stage an installed power of 3 MW (6 × 0.5 MW LFG power generators) and two flares of 2,000Nm^3/h. During this monitoring period, six power generators with a capacity of 3 MW (6 × 0.5) and one flare are mounted and operating. The starting date of construction was on Jul.1, 2007, the LFG flaring system was put into operation since 18/10/2007 and the operation of the LFG power generation system (3 × 0.5, including 1#, 2# and 3# generator) started on 04/03/2008, 4# and 5# generator were put into operation on 27/03/2012. 6# generator were put into operation on 10/10/2015.
   The leachate is treated by the landfill owner.
4. Total emission reductions achieved in this monitoring period is 147,497 ton CO_2eq.

A.2. Location of project activity

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This project is located in Tashan Farm, Chenxiang Town, SuJiatun District, Shenyang, Liaoning, People's Republic of China, with the GPS coordinates of 41°33' N and 123°34 E.

A.3. Parties and project participants

Parties involved	Project participants	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
China (host)	Shenyang Laohuchong Municipal Solid Waste Management Co. Ltd.	No
Italy	Asja Ambiente Italia S.p.A.	No
Switzerland	ICF - International Clean Fund LLC[1]	No

A.4. Reference to applied methodologies and standardized baselines

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Approved monitoring methodology and tools applied to this project:
ACM0001 - Version 6: “Consolidated baseline methodology for landfill gas project activity”
ACM0002 - Version 6: “Consolidated baseline methodology for grid-connected electricity generation from renewable sources”
Tool for the demonstration and assessment of additionality - Version 4
Tool to determine project emissions from flaring gases containing methane

Refer to the UNFCCC CDM website for the exact reference of the applied methodologies, tools and standardized baselines.

[1] Added on 13/07/2011, http://cdm.unfccc.int/Projects/DB/DNV-CUK1214898000.95/view

A.5. Crediting period type and duration

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The crediting period of this project activity is 25/12/2008-24/12/2018 (Fixed), and this monitoring period is 01/01/2017-31/12/2017.

SECTION B. Implementation of project activity

B.1. Description of implemented project activity

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The purpose of the project capturing and burning biogas, generating electricity, at the Shenyang Laohuchong Municipal Solid Waste Landfill.
The process includes LFG collecting, pre-treatment, power generation and flare combustion systems. The power plant is connected to local grid (North East Electric Power Grid) through transformer substation system.
The project is designed to have at its final stage an installed power of 3 MW (6 × 0.5 MW LFG power generators) and two flares of 2,000Nm^3/h. During this monitoring period, six power generators with a capacity of 3 MW (6 × 0.5, type: 500GF-N, G12V190ZLDZ-2, manufacture: Jinan Diesel Engine Co. Limited) and one flare are mounted and operating. The starting date of construction was on Jul.1, 2007, the LFG flaring system was put into operation since 18/10/2007 and the operation of the LFG power generation system (3 × 0.5, including 1#, 2# and 3# generator) started on 04/03/2008, 4# and 5# generator were put into operation on 27/03/2012. 6# generator were put into operation on 10/10/2015.

The whole project includes LFG collecting, pre-treatment, power generation and flare combustion systems. Asja Ambiente Italia S.p.A is responsible for all the design, construction, operation and maintenance process. Asja Ambiente Italia S.p.A has many years experience in LFG reutilization in 20 landfills in Italy.

Technical description of the main equipments:

Power Generation system:
The main technical specifications of the engines are provided in the following table:

Manufacture	JEDC
Type	500GF-N G12V190ZLDZ－2
Rated Capacity	500KW
Rated frequency	50 Hz
Rated voltage	400V
Rated current	902A

The main technical specifications of the enclosed flare are provided in the following table:

Type	TOR-30-A1
Manufacture	Shunfeng –Pioneer
Capacity	2,000m^3/h
Combustion efficiency	⩾ 98%

There were no events or situations occurred during the monitoring period, which impacted the applicability of the methodology.
There was no request to change the registered CDM project activity.

B.2. Post-registration changes

B.2.1. Temporary deviations from the registered monitoring plan, applied methodologies or standardized baselines

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N/A

B.2.2. Corrections

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N/A

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

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The start date of the crediting period has been changed from 01/01/2009 into 25/12/2008 and it has been accepted by the CDM EB.

B.2.4. Inclusion of monitoring plan

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N/A

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

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N/A

B.2.6. Changes to project design

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N/A

SECTION C. Description of monitoring system

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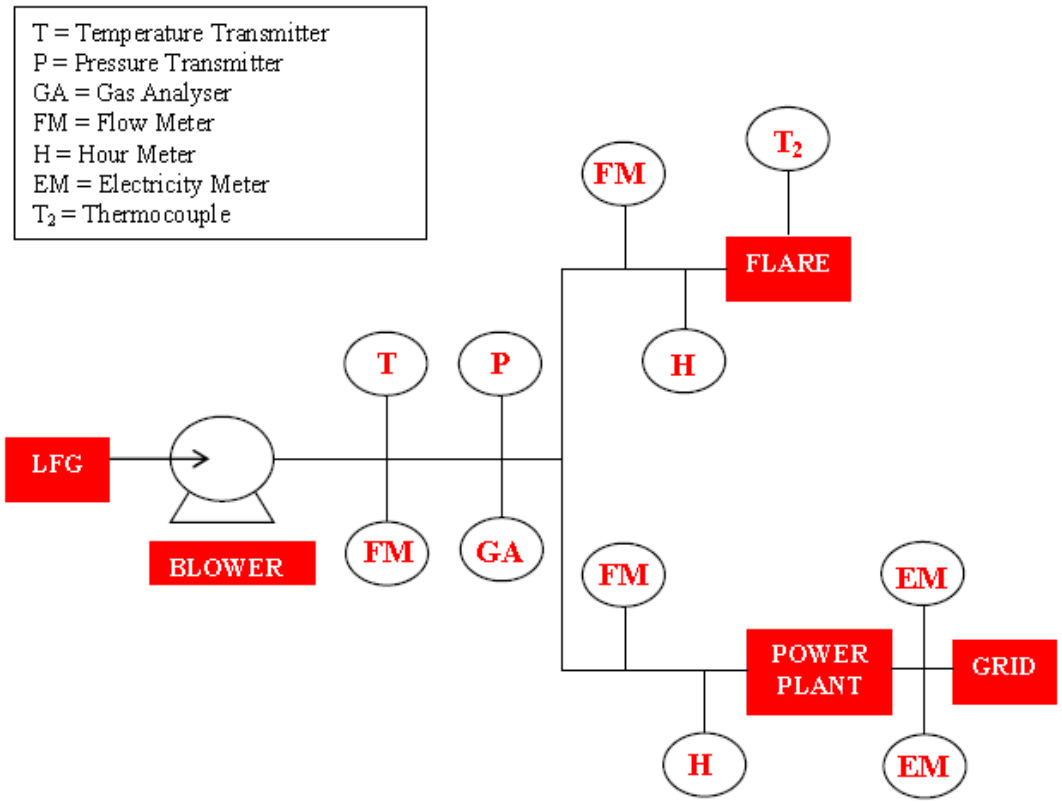
In order to determine the quantity of ERs generated during the project activity, the equipment shown in the following scheme (PDD Monitoring Plan) is installed.



The equipment of the analysing station and also the system equipments of the entire plant is connected through a Programmable Logic Controller (PLC) that let the operator quickly check the unit main variables through a user-friendly interface.

The system collects on a continuous basis the signals from the instruments equipping the main biogas lines, the suction station, the pressurised line going to the burning section and the generating sets.

Monitoring operating parameters on a continuous basis ensures the optimal management of the plant and the correct operation of the various devices installed (valves, blowers, etc.).

1.THE MONITORED DATA

According to the Monitoring Plan, the PLC system is designed to ensure the monitoring of the following main parameters:

- Landfill gas collected from project wells in the main line, LFG_{total}
- Landfill gas flow into flare, LFG_{flare}
- Landfill gas flow into power plant, $LFG_{electricity}$
- Methane in the landfill gas
- Temperature of flaring exhaust gas
- Operation of the energy plant and flare

Other operating parameter necessary to calculate the amount of ERs generated, manually recorded in specific forms (and confirmed by the official bills), are:

- Electricity imported from the power grid.
- Electricity exported to the power grid.

Besides, the local and national regulatory framework is also monitored.

Landfill gas flow, temperature and pressure

Landfill gas flow is measured by means of flow meters. Three flow meters are installed, one to measure the LFG flow into the flare, another one for the LFG flowing into the group of the operating engines and another one in order to measure the total landfill gas collected from project wells. For reporting purposes, these parameters are required to be normalized to 0°C and 1.01325bar. In order to normalize the volume measured by the flow meter to a standard temperature and pressure, a temperature transmitter and a pressure transmitter are used. These transmitters are integrated in each of the three flow meters, so that the value read on the display and the signal sent to the PLC are already normalized. According to the methodology ACM0001 version 06 (pag.14) “no separate monitoring of temperature and pressure is necessary when using flow meters that automatically measure temperature and pressure, expressing LFG volumes in normalized cubic meters.”

Temperature of the flare

N-type thermocouple is installed in the flare at 80% of its height as per the “*tool to determine project emissions from flaring gases containing methane*”(pag.13) and it is directly connected to the PLC.

Methane content in the landfill gas

Methane content in the landfill gas is measured by a gas analyzer with an infrared ray system analysis, with a scale range of 0-100 %Vol. The analyzer is directly connected to the PLC.

Operation of the energy plant and flares

The PLC counts the working hours of both the generating set and the flare.

Electricity exported to the power grid

Electricity exported to power grid is measured by a sealed energy meter. Since electricity meters belong and are managed by the Power Supply Company, the amount of electricity is proven by official electricity invoices. At midnight of every first day of the month, an operator writes down the values shown in the meter . The internal record is sent to Liaoning Power Grid Corporation via fax. After their confirmation and rounding, the related invoice is issued. Therefore the internal records, the Power Company records and the invoices (except for the rounding) always match.

Electricity imported from the power grid

Electricity imported from the power grid is measured by 2 sealed energy meters, which are installed on the low voltage side after the transformer connected to the plant access point of Xiaobu circuit of local grid (North East Electric Power Grid). Since electricity meters belong and are managed by the Power Supply Co., the amount of electricity is proven by official electricity invoices.
Once a month, usually during the first days, the workers of the Power Company come to read the power meters. Since they record these values together with our workers, the internal records always match with the records of the Power Company and the invoices.
The consumption calculation is based on the invoices and for the beginning and the end of the monitoring period, a conservative approach has been used.

Local and national regulatory framework
The local and national regulatory framework (related to the project) is monitored in order to verify that the project complies with the local and national regulation.

Emissions from flaring
The project proposed has adopted the default value for the flare efficiency for the enclosed flares of 90% according to the "*tool to determine project emissions from flaring gases containing methane*".

2.DATA MANAGEMENT SYSTEM (from the instruments to the monitoring sheets)

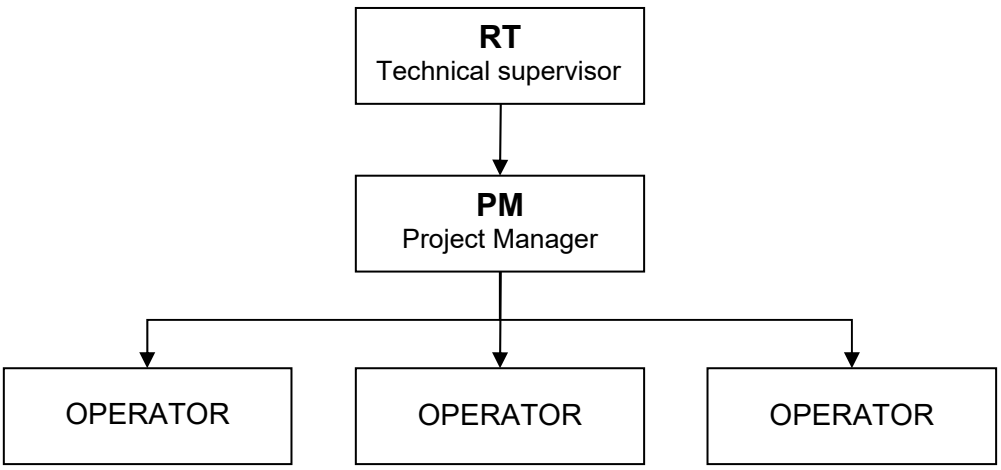
The PLC receives continuously the signals from all the monitoring instruments and shows the values on its touch-screen. This means that all the parameters are continuously monitored and available on-site. The PLC is directly connected to a Factory Data Storage system, hereinafter referred to as FDS. The PLC sends to the FDS all the monitored values. This industrial software for management of operating data, FDS, records every 5 minutes the values of all the monitored parameters and archives these values in a safe database. The database is accessible only through the FDS interface that allows only to read and to download the recorded data. This is to avoid any accidental loss or modification of the recorded data.
In summary, the signals flow from the instruments into a safe database in a complete automatic way, with no manual operations:

Instruments → PLC → FDS

All the FDS system and its data are continuously stored also in a back-up system in a portable hard-disk (mirroring).
All data, including calibration records and Monitoring Reports, will be kept until 2 years after the crediting period.

3.MONITORING ORGANIZATION

The plant is run by operators and by a project manager (PM) in charge of the necessary activities and checks. A technical responsible (RT) carries out the required checks on the plant on a periodic basis. **The PM is responsible for the maintenance and calibration of all the monitoring instruments and, therefore, for the proper working of the monitoring system.**



Technical Supervisor:
- Li Wei

Project Manager:
- Pan Libo

Workers:
- Jin Chunqiao
- Li Baobin
- Yao Gang
- Gao Debin
- Lv Huicao
- Li Mingyan

To assure a correct monitoring, the staff is trained on the following subjects:

- General knowledge about the equipment used in the landfill
- Reading and recording data
- Calibration methodology
- Emergency situation

A manual in English and Chinese with all the procedures for a correct management of the plant is always available on-site. This manual for plant management has:

- Description of the main parts of the equipment
- Maintenance instructions
- Calibration procedures
- Useful phone numbers

4.EMERGENCY PREPAREDNESS

Management of data not logged

Management of flow data not logged because of a failure
To reduce the time during which flow values cannot be logged because of a failure, the flow counter will be replaced with a spare unit as quickly as possible. In any case, there will be a brief time interval during which the system works without flow signals being received. In order to determine the flow during this time interval, the average flow value over the last 7 days of normal operation before the failure is used.
Management of gas analyzer data not logged because of a failure
To reduce the time during which the methane percentage values in the biogas cannot be logged because of a failure, the analyzer will be replaced with a spare unit as quickly as possible. In any case, there will be time interval during which the system works without the signals being received. In order to determine the percentage values during this time window, the average value over the last 7 days of normal operation before the failure is used.

Possible failure: No electrical power
When there is no electrical power the blower of the degassing installation cannot operate, so no landfill gas stream is available. No special actions are possible to avoid this. Therefore, when a black out occurs, no CERs are claimed.

SECTION D. Data and parameters

D.1. Data and parameters fixed ex ante

Data/Parameter	GWP_{CH4}
Unit	tCO_{2e}/tCH_4
Description	Global Warming Potential value for methane
Source of data	IPCC Fourth Assessment Report**:** Climate Change 2007
Value(s) applied	*25*
Choice of data or measurement methods and procedures	IPCC default value
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	

Data / Parameter:	$\rho_{CH4,n,h}$
Unit:	tCH_4/m^3CH_4
Description:	Density of methane gas at normal conditions
Source of data:	*Tool to determine project emissions from flaring gases containing methane*
Value(s) applied):	*0.0007168*
Choice of data or measurement methods and procedures	Parameter defined within the tool, “Tool to determine project emissions from flaring gases containing methane”
Purpose of data:	Calculation of baseline emissions
Additional comment:	

Data / Parameter:	$CEF_{elec,y}$
Unit:	tCO_2/MWh
Description:	The emission factor of northeast electric power grid
Source of data:	*Data published by China DNA on http://cdm.ccchina.gov.cn*
Value(s) applied):	*1.05176*
Choice of data or measurement methods and procedures	Official data
Purpose of data:	Calculation of both baseline emissions and project emissions
Additional comment:	

Data / Parameter:	Local and national regulatory framework
Unit:	
Description:	Law and regulations about waste management systems in China
Source of data:	*Data published by China DNA*

Value(s) applied):	<table><tr><th>Regulation reference</th><th>Regulation</th><th>Impact</th><th>Date of application</th></tr><tr><td>GB16889-1997</td><td>“Standard for Pollution Control on the Landfill Site of Municipal Solid Waste”</td><td>Included in PDD</td><td>01/01/1998</td></tr><tr><td>GB16889-2008</td><td>“Standard for Pollution Control on the Landfill Site of Municipal Solid Waste”</td><td>No impact on parameters monitored during the current crediting period. The methodology requires the impacts of new regulations to be considered at the renewal of the crediting period. The project has a fixed crediting period of 10 years and will not be renewed. Furthermore, the regulation is an E-type regulation according Annex 3 of EB 22.</td><td>01/07/2008</td></tr></table>
Choice of data or measurement methods and procedures	Official law and regulations
Purpose of data:	Calculation of baseline emissions
Additional comment:	

D.2. Data and parameters monitored

Data / Parameter:	$LFG_{total,y}$
Unit:	Nm^3
Description:	Total amount of landfill gas captured
Measured/ Calculated / Default:	*Measured*
Source of data:	*Flow meter*
Value(s) of monitored parameter:	*13,831,456*
Monitoring equipment:	Flow meter Type: Annubar 485 Accuracy class: ±0.9% Serial number: 01726699 Calibration frequency: Every year Date of calibrations: 01/09/2016 by Liaoning Provincial Institute of Measurement (Validity period: One year) 01/09/2017 by Liaoning Provincial Institute of Measurement (Validity period: One year)
Measuring/ Reading/ Recording frequency:	*The data is measured and read continuously, recorded every 5 minutes, aggregated hourly, daily, monthly and yearly, and archived electronically during the crediting period and two years after.*

Calculation method (if applicable):	
QA/QC procedures:	*Data with low level of uncertainty. QA/QC procedures are planned for these data. Flow meter is subject to regular maintenance and testing regime to ensure accuracy.* *Once a year, the flow meter is sent to a certified institute for external calibration (certificates are available for DOE)*
Purpose of data:	Used for baseline emission calculation.
Additional comment:	

Data / Parameter:	$LFG_{flare, y}$
Unit:	Nm^3
Description:	Amount of landfill gas flared
Measured/ Calculated / Default:	Measured
Source of data:	*Flow meter*
Value(s) of monitored parameter:	*61,783*
Monitoring equipment:	Flow meter Type: Annubar 285 Accuracy class: ±2% Serial number: 01746511 Calibration frequency: Every year Date of calibrations: 01/09/2016 by Liaoning Provincial Institute of Measurement (Validity period: One year) 01/09/2017 by Liaoning Provincial Institute of Measurement (Validity period: One year)
Measuring/ Reading/ Recording frequency:	*The data is measured and read continuously, recorded every 5 minutes, aggregated hourly, daily, monthly and yearly, and archived electronically during the crediting period and two years after.*
Calculation method (if applicable):	
QA/QC procedures:	*Data with low level of uncertainty. QA/QC procedures are planned for these data. Flow meter is subject to regular maintenance and testing regime to ensure accuracy.* *Once a year, the flow meter is sent to a certified institute for external calibration (certificates are available for DOE)*
Purpose of data:	*Used for baseline emission calculation.*
Additional comment:	

Data / Parameter:	$LFG_{electricity, y}$
Unit:	Nm^3
Description:	*Amount of landfill gas combusted in power plant*
Measured/ Calculated / Default:	Measured
Source of data:	*Flow meter*
Value(s) of monitored parameter:	*13,368,237*

Monitoring equipment:	Flow meter Type: Annubar 285 Accuracy class: ±2% Serial number: 01746510 Calibration frequency: Every year Date of calibrations: 01/09/2016 by Liaoning Provincial Institute of Measurement (Validity period: One year) 01/09/2017 by Liaoning Provincial Institute of Measurement (Validity period: One year)
Measuring/ Reading/ Recording frequency:	*The data is measured and read continuously for the group of all operating engines (not for each engine), recorded every 5 minutes, aggregated hourly, daily, monthly and yearly, and archived electronically during the crediting period and two years after.*
Calculation method (if applicable):	
QA/QC procedures:	*Data with low level of uncertainty. QA/QC procedures are planned for these data. Flow meter is subject to regular maintenance and testing regime to ensure accuracy.* *Once a year, the flow meter is sent to a certified institute for external calibration (certificates are available for DOE)*
Purpose of data:	*Used for baseline emission calculation.*
Additional comment:	

Data / Parameter:	$W_{CH4,y}$
Unit:	m^3CH_4/ m^3LFG
Description:	*Methane fraction in the landfill gas*
Measured/ Calculated / Default:	Measured
Source of data:	*Gas analyzer*
Value(s) of monitored parameter:	*Refer to the ER calculation spreadsheet for specific values*
Monitoring equipment:	Gas Analyzer Type: XGF-4043 Accuracy class: ≤2% Serial number: 0708404 Calibration frequency: Every year Date of calibrations:28/08/2016 by Liaoning Provincial Institute of Measurement (Validity period: One year) 28/08/2017 by Liaoning Provincial Institute of Measurement(Validity period: One year)
Measuring/ Reading/ Recording frequency:	*The data is measured continuously on wet basis, recorded every 5 minutes, and archived electronically during the crediting period and two years after.*
Calculation method (if applicable):	
QA/QC procedures:	*Data with low level of uncertainty. QA/QC procedures are planned for these data. Analyzer is subject to regular maintenance and testing regime to ensure accuracy. Once a month an internal calibration is carried out by using a certified sample gas. Once a year an external calibration is carried out by an authorized institute.*
Purpose of data:	*Used for baseline emission calculation.*
Additional comment:	

Data / Parameter:	EL_{LFG}
Unit:	*MWh*
Description:	*Net amount of electricity generated using landfill gas*
Measured/ Calculated / Default:	Measured
Source of data:	*Electricity meter*
Value(s) of monitored parameter:	*21,654.84*
Monitoring equipment:	Electricity meter Type: DSSD331-3 Accuracy class: 0.5s Serial number: 8007472 Calibration frequency: Every 5 years Date of last calibration: 10/10/2013 by Northeast Electric Power Research Institute Co.,Ltd ((Validity period: 5 years)
Measuring/ Reading/ Recording frequency:	*The data is measured continuously, aggregated and recorded monthly and yearly, and archived electronically during the crediting period and two years after.*
Calculation method (if applicable):	
QA/QC procedures:	*According to Chinese relevant regulations, the electricity metering equipment has been properly configured by the Power Supply company. The meters are calibrated by the grid company according to relevant National electricity measurement standards. Electricity metering equipment is checked and sealed by National Authority Measurement Department.*
Purpose of data:	*Used for baseline emission calculation.*
Additional comment:	

Data / Parameter:	EL_{PR}
Unit:	*MWh*
Description:	*Total amount of electricity required to meet the project requirement*
Measured/ Calculated / Default:	Measured
Source of data:	***2** Electricity meters*
Value(s) of monitored parameter:	Electricity meter A:*537.293* Electricity meter B: 0

Monitoring equipment:	**Electricity meter A** Type: DTZ188 Accuracy class: 0.5s Serial number: 010112300001515158 Calibration frequency: Every 5 years Date of calibrations: 17/07/2013 by Northeast Electric Power Research Institute Co.,Ltd (Validity period: 5 years) **Electricity meter B** Type: DTS51 Accuracy class: 1 Serial number: 0103200019480 Calibration frequency: Every 5 years Date of calibrations: 26/12/2013 by Northeast Electric Power Research Institute Co.,Ltd (Validity period: 5 years)
Measuring/ Reading/ Recording frequency:	*The data is measured continuously, recorded every month (according to the official bills), and archived electronically during the crediting period and two years after.*
Calculation method (if applicable):	
QA/QC procedures:	*According to Chinese relevant regulations, the electricity metering equipment has been properly configured by the Power Supply company. The meters are calibrated by the grid company according to relevant National electricity measurement standards. Electricity metering equipment is checked and sealed by National Authority Measurement Department.*
Purpose of data:	*Used for Project emission calculation.*
Additional comment:	

Data / Parameter:	T_{flare}
Unit:	*°C*
Description:	*Temperature in the exhaust gas of the enclosed flare*
Measured/ Calculated / Default:	Measured
Source of data:	*N-type Thermocouple*
Value(s) of monitored parameter:	*Refer to the ER calculation spreadsheet for specific values*
Monitoring equipment:	Thermocouple Type: WRMK-331 Calibration frequency: Replaced before one year from manufacturing (therefore no calibration is needed) Dates of replacements:26/12/2016(Manufacturing date 23/12/2016) 25/12/2017(Manufacturing date 21/12/2017)
Measuring/ Reading/ Recording frequency:	*The data is measured continuously, recorded every 5 minutes, and archived electronically during the crediting period and two years after.*
Calculation method (if applicable):	
QA/QC procedures:	*Thermocouple is replaced by a new one every year to ensure accuracy.*
Purpose of data:	*Used for baseline emission calculation.*
Additional comment:	

Data / Parameter:	EWH
Unit:	*h*
Description:	*Engine working hours of power plant*

Measured/ Calculated / Default:	measured
Source of data:	*Hour meter of the PLC (Programmable Logic Controller)*
Value(s) of monitored parameter:	*8,714*
Monitoring equipment:	PLC, Programmable Logic Controller Type: Siemens S7-300 Accuracy: Deviation per day: < 10 s
Measuring/ Reading/ Recording frequency:	*The data is measured continuously for the group of all operating engines, recorded every 5 minutes, and archived electronically during the crediting period and two years after.*
Calculation method (if applicable):	
QA/QC procedures:	*Equipment is maintained in line with manufacturer recommendations to assure high quality output.*
Purpose of data:	*Used for baseline emission calculation.*
Additional comment:	

Data / Parameter:	FWH
Unit:	*h*
Description:	*Flare working hours*
Measured/ Calculated / Default:	Measured
Source of data:	*Hour meter of the PLC (Programmable Logic Controller)*
Value(s) of monitored parameter:	*260*
Monitoring equipment:	PLC, Programmable Logic Controller Type: Siemens S7-300 Accuracy: Deviation per day: < 10 s
Measuring/ Reading/ Recording frequency:	*The data is measured continuously, recorded every 5 minutes, and archived electronically during the crediting period and two years after.*
Calculation method (if applicable):	
QA/QC procedures:	*Equipment is maintained in line with manufacturer recommendations to assure high quality output.*
Purpose of data:	*Used for baseline emission and project emission calculation.*
Additional comment:	

Data / Parameter:	$PE_{flare,y}$
Unit:	tCO_2
Description:	*Project emission from flaring of the residual gas stream in year y*
Measured/ Calculated / Default:	Calculated using the biogas flow to the flare FV_RG,h , the methane content in the biogas $fv_{CH4,RG,h}$ and the flare efficiency. For the flare efficiency the default values for enclosed flare are used, as per the "Tool to determine project emissions from flaring gases containing methane" , and therefore the only parameter needed, besides $LFG_{flare,y}$ and $fv_{CH4,RG,h}$, is T_{flare}.
Source of data:	
Value(s) of monitored parameter:	*130.22*

Monitoring equipment:	-
Measuring/ Reading/ Recording frequency:	-
Calculation method (if applicable):	*As per the methodological "Tool to determine project emission from flaring gases containing methane"*
QA/QC procedures:	
Purpose of data:	*Used for baseline emission calculation*
Additional comment:	

Data / Parameter:	$fv_{CH4,RG,h}$
Unit:	-
Description:	*Volume fraction of methane in the residual gas on dry basis in hour h*
Measured/ Calculated / Default:	Measured
Source of data:	*Gas analyzer*
Value(s) of monitored parameter:	*Refer to the ER calculation spreadsheet for specific values*
Monitoring equipment:	Gas Analyzer Type: XGF-4043 Accuracy class: ≤2% Serial number: 0708404 Calibration frequency: Every year Date of calibrations: 28/08/2016 by Liaoning Provincial Institute of Measurement (Validity period: One year) 28/08/2017 by Liaoning Provincial Institute of Measurement(Validity period: One year)
Measuring/ Reading/ Recording frequency:	*The data is measured continuously, recorded every 5 minutes, and archived electronically during the crediting period and two years after.*
Calculation method (if applicable):	
QA/QC procedures:	*Data with low level of uncertainty. QA/QC procedures are planned for these data. Analyzer is subject to regular maintenance and testing regime to ensure accuracy. Once a month an internal calibration is carried out by using a certified sample gas. Once a year an external calibration is carried out by an authorized institute.*
Purpose of data:	*Used for* PE_{flare} *emission calculation of baseline.*
Additional comment:	

Data / Parameter:	$FV_{RG,h}$
Unit:	m^3/h
Description:	Volumetric flow rate of the residual gas in dry basis at normal conditions in the hour h
Measured/ Calculated / Default:	Measured
Source of data:	*Flow meter*
Value(s) of monitored parameter:	*Variable*

Monitoring equipment:	Flow meter Type: Annubar 285 Accuracy class: ±2% Serial number: 01746511 Calibration frequency: Every year Date of calibrations:01/09/2016 by Liaoning Provincial Institute of Measurement (Validity period: One year) 01/09/2017 by Liaoning Provincial Institute of Measurement(Validity period: One year)
Measuring/ Reading/ Recording frequency:	*The data is measured and read continuously, recorded every 5 minutes, and archived electronically during the crediting period and two years after.*
Calculation method (if applicable):	
QA/QC procedures:	*Data with low level of uncertainty. QA/QC procedures are planned for these data. Flow meter is subject to regular maintenance and testing regime to ensure accuracy.* *Once a year, the flow meter is sent to a certified institute for external calibration (certificates are available)*
Purpose of data:	*Used for* PE_{flare} *emission calculation of baseline.*
Additional comment:	

D.3. Implementation of sampling plan

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N/A

SECTION E. Calculation of emission reductions or net anthropogenic removals

The greenhouse gas emission reduction achieved by the project activity during a given year "y" (ERy) are estimated as follows:

$$ER_y = (MD_{project,y} - MD_{reg,y}) * GWP_{CH4} + EL_{LFG,y} * CEF_{elec,B,y} - EL_{PR,y} * CEF_{elec,PR,y} + ET_{LFG.y} * CEF_{ther,BL,y} - ET_{PR,y} * CEF_{ther,PR,y}$$

Where:

- ER_y = Emissions reduction, in tons of tCO_2 equivalent (tCO_{2eq})
- $MD_{project,y}$ = Amount of methane that would have been destroyed/combusted during the year, in tons of methane (tCH_4)
- $MD_{reg,y}$ = Amount of methane that would have been destroyed/combusted during the year in the absence of the project, in tons of methane (tCH_4)
- GWP_{CH4} = Global Warming Potential of methane (tCO_2eq/tCH_4)
- $EL_{LFG,y}$ = Net quantity of electricity produced using LFG exported which in the absence of the project activity would have been produced by power plants connected to the grid or by an on-site/off-site fossil fuel based captive power generation, during year y, in megawatt hours(MWh)
- $CEF_{elec,BL,y}$ = CO_2 emissions intensity of the baseline source of electricity displaced (tCO_2eq/MWh)
- EL_{PR} = Amount of electricity generated in an on-site fossil fuel fired power plant or imported from the grid as a result of the project activity, measured using an electricity meter (MWh)
- $ET_{LFG.y}$ = Quantity of thermal energy produced utilizing the landfill gas, which in the absence of the project activity would have been produced from onsite/offsite fossil fuel fired boiler, during the year y (TJ/y)
- $CEF_{ther,BL,y}$= CO_2 emissions intensity of the fuel used by boiler to generate thermal energy which is displaced by LFG based thermal energy generation (tCO_{2e}/TJ)
- $ET_{PR,y}$ = fossil fuel consumption on site during project activity in year y (ton)
- $CEF_{ther,PR,y}$= CO_2 emissions factor of the fossil fuel used by boiler to generate thermal energy in the project activity during year y.

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

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According to the applicable methodologies, the baseline emission (BE_y), achieved by the project activity for this monitoring period are calculated as follows:

$$BE_y = (MD_{project,y} - MD_{reg,y}) * GWP_{CH4} + EL_{LFG,y} * CEF_{elec,B,y} + ET_{LFG,y} * CEF_{ther,BL,y}$$

The project does not consume or produce thermal energy, therefore:

$ET_{LFG,y} = 0$

1. Calculation of $MD_{project,y}$

Calculations are then made according to the following formula:

$MD_{project,y} = MD_{flare,y} + MD_{electricity,y}$

$MD_{flare,y} = (LFG_{flare,y} * w_{CH4,y} * D_{CH4,y}) - (PE_{flare,y} / GWP_{CH4})$

$MD_{electricity,y} = LFG_{electricity,y} * w_{CH4,y} * D_{CH4,y}$

The methane fraction of the LFG during this monitoring period is measured continuously, and recorded every 5 minutes like all the other monitored parameters.

$PE_{flare,y}$ is the project emission from flaring of the residual gas stream determined following the procedure described in the "Tool to determine project emissions from flaring gases containing Methane":

$$PE_{flare,y} = \sum_{h=1}^{8760} TM_{RG,h} \times (1 - \eta_{flare,h}) \times \frac{GWP_{CH4}}{1000}$$

Where:

$PE_{flare.}$	= Project emissions from flaring of the residual gas stream (tCO_{2e}/y)
$TM_{RG,h}$	= Mass flow rate of methane in the residual gas in the hour *h* (kg/h)
$\eta_{flare,h}$	= Flare efficiency in hour *h*
GWP_{CH4}	= Global Warming Potential of methane valid for the commitment period (tCO_2e/tCH_4)

The quantity of methane in the residual gas that goes into the flare is:

$$TM_{RG,h} = FV_{RG,h} \times fv_{CH4,RG,h} \times \rho_{CH4,n}$$

Where:

$TM_{RG,h}$	= Mass flow rate of methane in the residual gas in the hour (kg/h)
$FV_{RG,h}$	= Volumetric flow rate of the residual gas in dry basis at normal conditions in hour *h* (m^3/h)
$fv_{CH4,RG,h}$	= Volumetric fraction of methane in the residual gas on dry basis in hour *h* (NB: this corresponds to $fv_{i,RG,h}$ where i refers to methane)
$\rho_{CH4,n}$	= Density of methane at normal conditions (kg/m^3)

In this project, the flare is enclosed and default value for the flare efficiency is adopted. The temperature of the exhaust gas of the flare is measured continuously. Therefore flare efficiency in the hour *h* is then:

- 90%, if the temperature of the flare's (T_{flare}) exhaust is above 500 ºC 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*.
- 50%, if the temperature of the flare's (T_{flare}) exhaust is above 500 ºC for more than 40 minutes during the hour *h*, but the manufacturer's specifications on proper operation of the flare are not met at any point in time during the hour *h*.
- 0%, if the temperature of the flare's (T_{flare}) exhaust is below 500 ºC more than 20 minutes during the hour *h*.

Flare efficiency calculated as above is than assigned to each hour of the monitoring period and used to calculate the Project Emissions. During the monitoring period the flare has been operated in compliance with manufacturer's specifications.

Monitoring Period 01/01/2017 – 31/12/2017	**[tCO_2]**

$PE_{flare,y}$	**130.22**

According to the applicable methodologies, the sum of the quantities fed to the flare(s), to the power plant(s) must be compared annually with the total quantity of methane generated, and all the three parameters were recorded and compared every 5 minutes during the monitoring period for a conservative approach. The lowest value of the two must be adopted as $MD_{project,y}$. For example, these three parameters recorded at 0 o'clock on July 28th, 2017 are shown as follows:

	Flow Rate - Main Pipe	Flow Rate - Flare	Flow Rate - Engines
Time	[Nm^3/h]	[Nm^3/h]	[Nm^3/h]
28/07/17 00:00:00	1,746	0	1,687

Methane destroyed by the project activity ($MD_{project,y}$) during each monitoring period is determined as follows:

- the sum (1,687 Nm^3/h) of the quantities fed into the flare (0 Nm^3/h), to the power plant (1,687 Nm^3/h) is compared with the total LFG captured (1,746 Nm^3/h);
- the lower value (1,687 Nm^3/h) of the two is then adopted as $MD_{project,y}$ for a conservative approach.

Therefore, according to the above quoted formulae and to the spreadsheet, the result of $MD_{project,y}$ is the following:

Monitoring Period 01/01/2017 – 31/12/2017	**[tCO_2]**
$MD_{project,y}*GWP_{CH4}$	**125,288**

2.Calculation of $MD_{reg,y}$

$MD_{reg,y} = MD_{project,y} * AF$

As per the registered PDD, there are no regulatory or contractual requirements that obligate to install a specific system for collection and destruction of LFG or to collect and destroy a specific percentage of the "generated" amount of biogas, the adjustment factor (AF) is then assumed to be "0" for this project.
Hence,

Monitoring Period 01/01/2017 – 31/12/2017	**[tCH_4]**
$MD_{reg,y}$	0

3.Calculation of $EL_{LFG,y}*CEF_{elec,BL,y}$

Since the plant is connected to the North East Electric Power Grid, its carbon emissions factor has been chosen for exported electricity:

$CEF_{elec,BL,y} = 1.05176\ tCO_{2eq}/MWh$

The calculation result of $EL_{LFG,y}*CEF_{elec,BL,y}$ during this monitoring period is shown as follows:

Monitoring Period	$EL_{LFG,y}$ [MWh]	$CEF_{elec,BL,}$ [tCO_{2eq}/MWh]	$EL_{LFG,y}*CEF_{elec,BL,y}$ [tCO_2]
01/01/2017 – 31/12/2017	21,654.84	1.05176	22,775

Evidences for $EL_{LFG,y}$ values are the available official invoices.

Monitoring Period	$MD_{project,y}*GWP_{CH4}$ [tCO_2]	$EL_{LFG,y}*CEF_{elec,BL,y}$ [tCO_2]	BEy [tCO_2]
01/01/2017 – 31/12/2017	125,288	22,775	148,063

Refer to the ER calculation spreadsheet for detailed calculation process.

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

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According to the applicable methodologies, the project emission includes two parts: 1) the electricity consumption on site during the project; 2) the thermal energy consumption on site during the project. The project does not consume or produce thermal energy, therefore, the project emission only includes on-site electricity consumption

$$PE_y = EL_{PR,y} * CEF_{elec,PR,y} + ET_{PR,y} * CEF_{ther,PR,y} = EL_{PR,y} * CEF_{elec,PR,y}$$

The calculation result of the PE_y during this monitoring period is shown as follows, evidences for EL_{PRy} values are the available official bills and invoices.

Monitoring Period	$EL_{PR,y}$ [MWh]	$CEF_{elec,PR,}$ [tCO_{2eq}/MWh]	$EL_{LFG,y}*CEF_{elec,PR,y}$ [tCO_2]	PE_y [tCO_2]
01/01/2017 – 31/12/2017	537.293	1.05176	566	566

Refer to the ER calculation spreadsheet for detailed calculation process.

E.3. Calculation of leakage emissions

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According to the applicable methodologies and registered PDD, there is no leakage in this project.

E.4. Calculation of emission reductions or net anthropogenic removals

	Baseline GHG emissions or baseline net GHG removals (t CO_2e)	Project GHG emissions or actual net GHG removals (t CO_2e)	Leakage GHG emissions (t CO_2e)	GHG emission reductions or net anthropogenic GHG removals (t CO_2e)		
				Before 01/01/2013	From 01/01/2013	Total amount
Total	148,063	566	0	0	147,497	147,497

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_2e)	Amount estimated ex ante (t CO_2e)
147,497	167,687

E.6. Remarks on increase in achieved emission reductions

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The actual emission reductions are lower than the value expected in the registered PDD.