Monitoring report form

(Version 05.1)

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 monitoring report	03	
Completion date of the monitoring report	31/08/2015	
Monitoring period number and duration of this monitoring period	Monitoring period 04 and 01/08/2014-30/06/2015(both days included)	
Project participant(s)	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 scope(s)	1-Energy industry(renewable and non-renewable sources);13-waste handling and disposal	
Selected methodology(ies)	ACM0001(Version 06) ; ACM0002(Version 06) ;	
Selected standardized baseline(s)	_	
Estimated amount of GHG emission reductions or net GHG removals by sinks for this monitoring period in the registered PDD	155,741	
Total amount of GHG emission reductions or net GHG removals by sinks achieved in this monitoring period	GHG emission reductions or net GHG removals by sinks reported up to 31 December 2012	GHG emission reductions or net GHG removals by sinks reported from 1 January 2013 onwards
	0	155,741

SECTION A. Description of project activity

A.1. Purpose and 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, five power generators with a capacity of 2.5MW (5 × 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.
   The leachate is treated by the landfill owner.
4. Total emission reductions achieved in this monitoring period is 155,741 ton CO_2eq.

A.2. Location of project activity

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This project is located in Tashan Farm, Chenxiang Town, Su Jiatun 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 participant(s)

Party involved ((host) indicates a host Party)	Private and/or public entity(ies) project participants (as applicable)	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 of applied methodology and standardized baseline

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Approved monitoring methodology and tools applied to this projects:

ACM0001 - Version 6: “Consolidated baseline methodology for landfill gas project activity”

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

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.

A.5. Crediting period of project activity

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The Crediting period of this project activity is 25/12/2008 -24/12/2018 (Fixed).

A.6. Contact information of responsible persons/entities

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The monitoring report is completed in July 2015, and the responsible persons are:

Cui jianshuang, Diao Xianlan
Asja Renewables (shenyang) Co., Ltd
Address: Shenyang LN, P.R. China
Tel:+86 24.23 987210
Fax: +86 24.23 987133
Email: c.cui@ asja.cn, xl.diao@ asja.cn

SECTION B. Implementation of project activity

B.1. Description of implemented registered 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, five power generators with a capacity of 2.5MW (5 × 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.

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 registered monitoring plan, applied methodology or applied standardized baseline

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N/A

B.2.2. Corrections

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N/A.

B.2.3. Changes to start date of 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 a monitoring plan to the registered PDD that was not included at registration

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N/A.

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

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N/A.

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

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N/A.

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

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N/A.

SECTION C. Description of monitoring system

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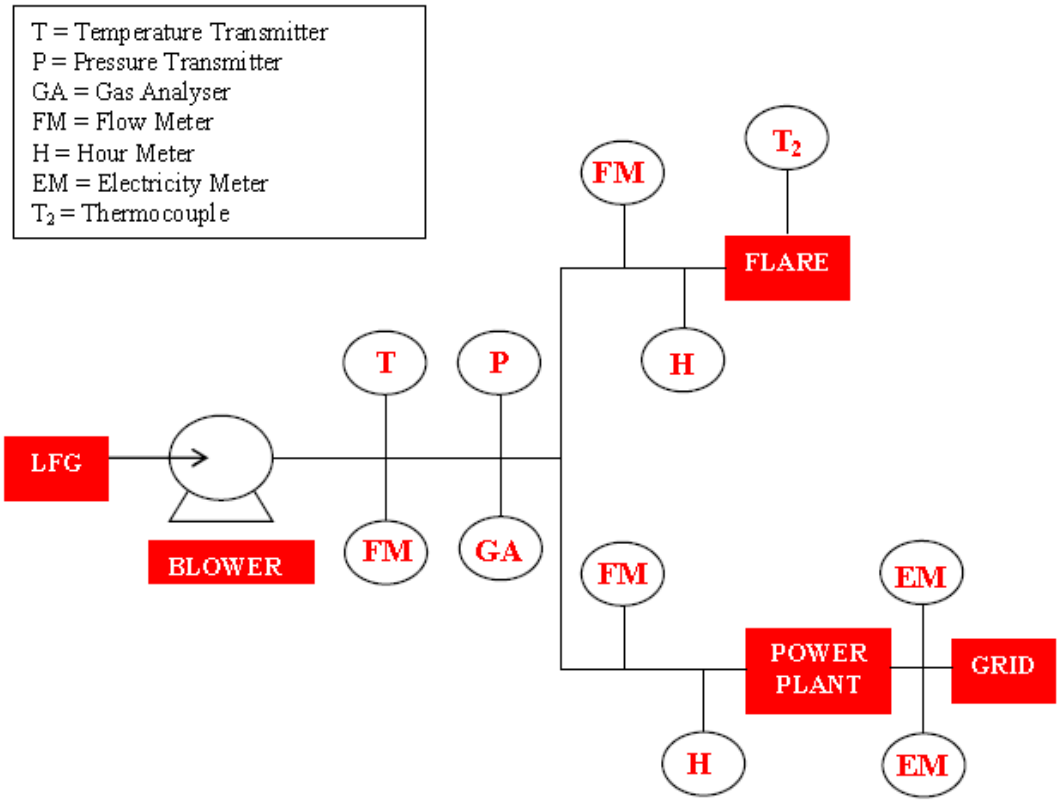
In order to determine the quantity of ERs generated during the project activity, the equipment shown in the following scheme (PDD Monitoring Plan) is installed.



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)

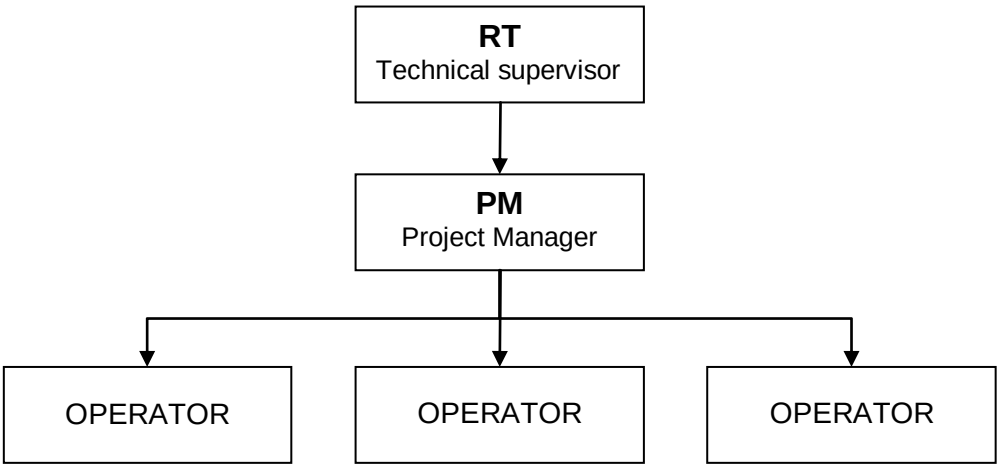
The PLC receives continuously the signals from all the monitoring instruments and shows the values on its touch-screen. This means that all the parameters are continuously monitored and available on-site. The PLC is directly connected to a Factory Data Storage system, hereinafter referred to as FDS. 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 or at renewal of crediting period

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*
Purpose of data:	Used for baseline emission calculation
Additional comment:	

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*
Purpose of data:	Used for baseline emission calculation
Additional comment:	

Data / Parameter:	$CEF_{elec,y}$
Unit:	tCO2/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*
Purpose of data:	Used for both baseline and project emission calculations
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):

Regulation reference	Regulation	Impact	Date of application
GB16889-1997	"Standard for Pollution Control on the Landfill Site of Municipal Solid Waste"	Included in PDD	01/01/1998
GB16889-2008	"Standard for Pollution Control on the Landfill Site of Municipal Solid Waste"	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.	01/07/2008

Purpose of data:	Used for baseline emission calculation
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:	*15,524,848*

Monitoring equipment:	Flow meter Type: Annubar 485 Accuracy class: ±0.9% Serial number: 01726699 Calibration frequency: Every year Date of calibrations: 09/09/2013 by Liaoning Provincial Institute of Measurement (valid until 08/09/2014) 05/09/2014 by Liaoning Provincial Institute of Measurement (valid until 04/09/2015)
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:	*5,805,508*
Monitoring equipment:	Flow meter Type: Annubar 285 Accuracy class: ±2% Serial number: 01746509 from 01/08/2014 to 05/09/2014 Calibration frequency: Every year Date of calibrations: 09/09/2013 by Liaoning Provincial Institute of Measurement (valid until 08/09/2014) Type: Annubar 285 Accuracy class: ±2% Serial number: 01746511 from 05/09/2014 to 30/06/2015 Calibration frequency: Every year Date of calibrations: 02/09/2014 by Liaoning Provincial Institute of Measurement (valid until 01/09/2015)
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:	*9,756,850*
Monitoring equipment:	Flow meter Type: Annubar 285 Accuracy class: ±2% Serial number: 01746510 Calibration frequency: Every year Date of calibrations: 09/09/2013 by Liaoning Provincial Institute of Measurement (valid until 08/09/2014) 05/09/2014 by Liaoning Provincial Institute of Measurement (valid until 04/09/2015)
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: 31/08/2013 by Liaoning Provincial Institute of Measurement (valid until 30/08/2014) 30/08/2014 by Liaoning Provincial Institute of Measurement (valid until 29/08/2015)
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:	*14,305.2*
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 (valid until 09/10/2018)
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:*358.929* 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 (valid until 16/07/2018) **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 (valid until 25/12/2018)
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:18/02/2014(Manufacturing date 15/01/2014) 29/12/2014(Manufacturing date 15/12/2014)
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:	*7,905*
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:	*7,643*

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}
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:	*5,485,78*
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: 31/08/2013 by Liaoning Provincial Institute of Measurement (valid until 30/08/2014) 30/08/2014 by Liaoning Provincial Institute of Measurement (valid until 29/08/2015)
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: 01746509 from 01/08/2014 to 05/09/2014 Calibration frequency: Every year Date of calibrations: 09/09/2013 by Liaoning Provincial Institute of Measurement (valid until 08/09/2014) Type: Annubar 285 Accuracy class: ±2% Serial number: 01746511 from 05/09/2014 to 30/06/2015 Calibration frequency: Every year Date of calibrations: 02/09/2014 by Liaoning Provincial Institute of Measurement (valid until 01/09/2015)
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 GHG removals by sinks

E.1. Calculation of baseline emissions or baseline net GHG removals by sinks

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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:

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

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 (tCH4)
- GWP_{CH4} = Global Warming Potential of methane (tCO2eq/tCH4)
- $EL_{LFG,y}$ = 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)
- $CEF_{elec,BL,y}$ = CO2 emissions intensity of the baseline source of electricity displaced (tCO2eq/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.

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 01/08/2014 – 30/06/2015	**[tCO_2]**
$PE_{flare,y}$	**5,485.78**

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 August 1st, 2014 are shown as follows:

	Flow Rate - Main Pipe	Flow Rate - Flare	Flow Rate - Engines
Time	[Nm^3/h]	[Nm^3/h]	[Nm^3/h]
01/08/14 00:00:00	1796	450	1364

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

- the sum (1814 Nm^3/h) of the quantities fed into the flare (450 Nm^3/h), to the power plant (1364 Nm^3/h) is compared with the total LFG captured (1796 Nm^3/h);
- the lowest value (1796 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 01/08/2014 – 30/06/2015	**[tCO_2]**
$MD_{project,y}*GWP_{CH4}$	**141,074**

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 01/08/2014 – 30/06/2015	**[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]
01/08/2014 – 30/06/2015	14,305.2	1.05176	15,045

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]
01/08/2014 – 30/06/2015	141,074	15,045	156,119

Refer to the ER calculation spreadsheet for detailed calculation process.

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

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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 and 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]
01/08/2014 – 30/06/2015	358.929	1.05176	378	378

Refer to the ER calculation spreadsheet for detailed calculation process.

E.3. Calculation of leakage

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

E.4. Summary of calculation of emission reductions or net GHG removals by sinks

Item	Baseline emissions or baseline net GHG removals by sinks (t CO_2e)	Project emissions or actual net GHG removals by sinks (t CO_2e)	Leakage (t CO_2e)	GHG emission reductions or net GHG removals by sinks (t CO_2e) achieved in the monitoring period		
				Up to 31/12/2012	From 01/01/2013	Total amount
Total	156,119	378	–	0	155,741	155,741

E.5. Comparison of actual emission reductions or net GHG removals by sinks with estimates in registered PDD

Item	Values estimated in ex ante calculation of registered PDD	Actual values achieved during this monitoring period
Emission reductions or GHG removals by sinks (t CO_2e)	136,480[2]	155,741

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

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The comparison shows that the actual emission reductions 155,741 tCO_2e are greater than 136,480 tCO_2e.expected in the registered PDD, this is because that the GWP_{CH4} has been updated into 25 from 21 as per EB's guidance, when the GWP_{CH4} 21 was taken into calculation, the actual emission reductions 133,169 tCO_2e are still lower than the value expected in the registered PDD..

[2] As per the registered PDD, the annual estimation of emission reductions in 2014 and 2015 are 142,354 ton CO_2e and 154,891 ton CO_2e respectively, and the monitoring period is 01/08/2014- 30/06/2015, totally 334 days including 153 days in 2014, 181 in 2015, thus the total estimation of emission reductions=142,354/365*153+154,891/365*181=136,480 ton CO_2e

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

Project participant and/or responsible person/ entity	☒ Project participant ☐ Person/entity responsible for completing the CDM-MR-FORM
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