UNFCCC Clean Development Mechanism Monitoring Report

Shenzhen Xiaping Landfill Gas Collection and Utilization Project

CDM registration number: 0887

Monitoring period: 01/02/2009-30/09/2009

Document ID: CDM0887-MR04-03

Date: 31 May 2010

Project background

Shenzhen Xiaping Landfill Gas Collection and Utilization Project (hereinafter simply as Xiaping LFG Project) has been registered as CDM project by the UNFCCC on 4 May 2007 under reference number 0887, the first crediting period is 7 years commencing on 1 July 2007 ending on 30 June 2014.

Further background on this project can be found in the Project Design Document (PDD) and associated documents, which is available on the UNFCCC website:
http://cdm.unfccc.int/Projects/DB/SGS-UKL1169636952.02/view.html

Parties involved are China (Host Country) and the United Kingdom of Great Britain and Northern Ireland (Annex Party). The project participants are Shenzhen Lisai Development Co. Ltd. (project developer and operator) and Climate Change Capital Carbon Fund s.à r.l. (carbon buyer).

The Implementation Status of the Project during the monitoring period

The project is implemented as planned. It includes three main activities: construction and operation of LFG collection system, construction and operation of an 8MW LFG power plant and construction and operation of a flaring system. The emission reduction attributable to the displacement of grid electricity by the Project Activity was claimed by the project developer in PDD for the first seven year commitment period.

As of this verification period, six generators (1*1.048MW, 3*1.064MW, 2*1.100MW generators) have been installed and the total installation capacity amounts to 6.44MW. The first stage work of Xiaping LFG project for construction of landfill gas collection system, one flare and three power generation facilities with a capacity of 3.176MW (1*1.048MW, 2*1.064MW generators)were completed respectively in 2006 and 2007. The second stage work for the other flare and two more generators (2*1.100MW generators) were completed respectively in 2007 and 2008. The sixth generator with a capacity of 1.064MW was installed and put into operation in 22 July 2009. Two flares were installed and the efficiency of both is yearly measured and quantified. The emission reductions resulted from combusting of both flares is claimed in this period.

Reference to any deviation request approved by the Executive Board

The monitoring plan has been approved to be revised once by the Executive Board on 31 May 2008. According to the revised monitoring plan, the project owner replaced the original one main pipe with two paralleled ones in October 2008 and a flow meter is installed on each pipe. Since the total flow rate falls within the range of one flow meter, the other one does not work for measurement during this monitoring period. The landfill gas in the other main pipe is recorded zero accordingly. There is no deviation during this monitoring period.

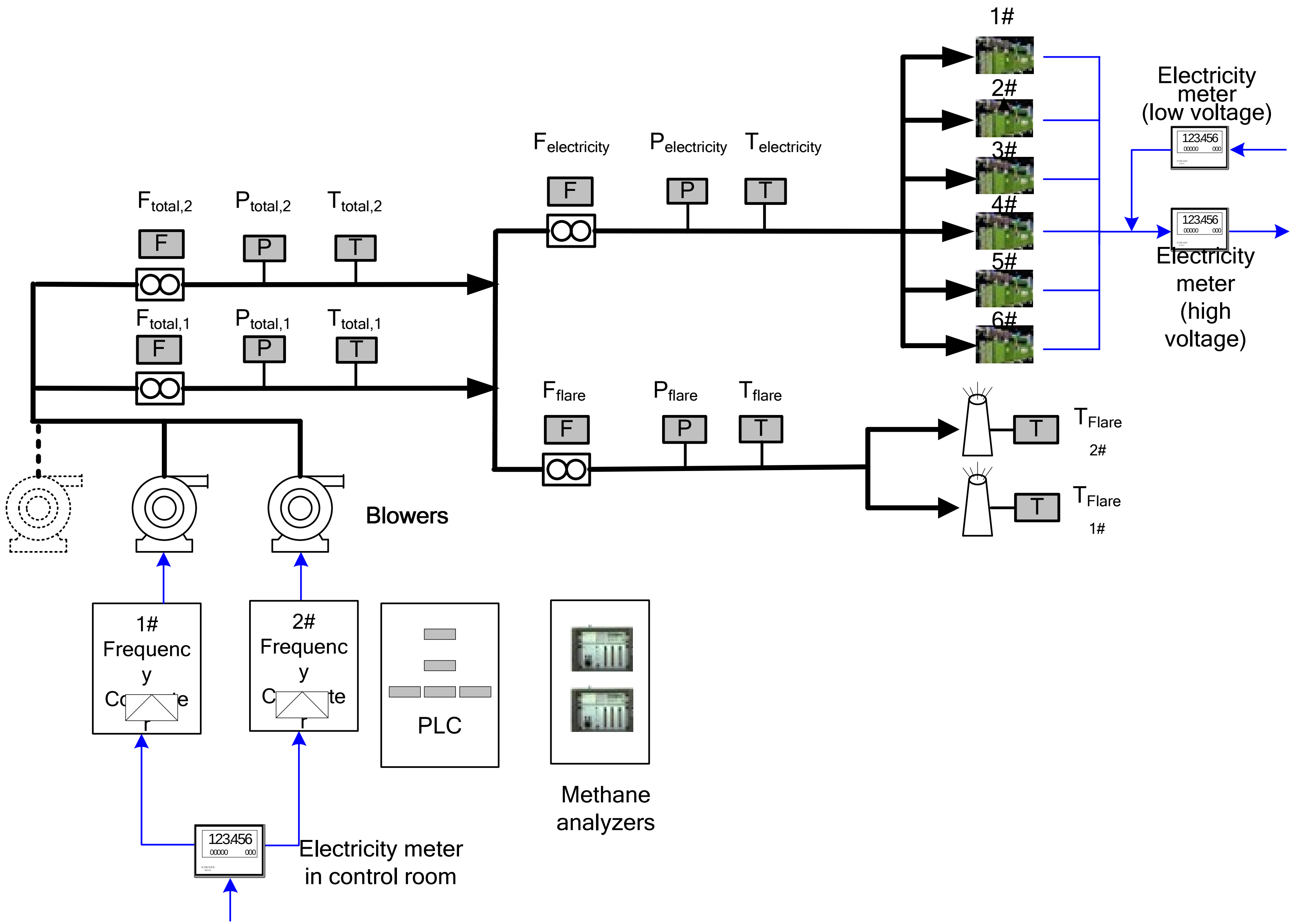
Methodologies applied by the project

The calculation of emission reductions applies methodologies ACM0001 (version 04 of 28/7/06) and AMS-I.D. (version 9 of 28/7/06), which are described in the monitoring plan of PDD.

The validated monitoring plan has been reflected in the Monitoring Manual of "Xiaping LFG Project CDM Management Manual", which was edited by the project developer in June 2007, revised four times later, and carried out by the staff of Xiaping LFG Project.

There are no remaining open issues related to monitoring after completion of project validation.

Monitoring Systems and Procedures &QC measures



1#
2#
3#
4#
5#
6#
Electricity meter (low voltage)
123456
Electricity meter (high voltage)
F electricity
P electricity
T electricity
F total,2
P total,2
T total,2
F total,1
P total,1
T total,1
F flare
P flare
T flare
T Flare 2#
T Flare 1#
F
P
T
Blowers
1# Frequency Converter
2# Frequency Converter
PLC
Methane analyzers
Electricity meter in control room

The landfill gas is collected and transferred to generators and flares through two main pipelines as mentioned in the revised monitoring plan. It is noted from the figure that a flow meter (F), pressure sensor (P) and temperature sensor (T) have been installed on each pipe to monitor the flow rate and operation condition of the system. The data acquisition system (referred to as PLC system) is developed to monitor the monitoring procedures automatically.

All monitoring data have been quality controlled by the following measures:

1. Certification or License provided by the manufacturers of the gas flow meter, methane fraction meter, temperature sensor and pressure sensor as well as electricity meter production.
2. Calibration Certificates of flow meter, methane fraction meter, temperature sensor, pressure sensor and electricity meter Supplier issued by Government Authorized Metering Monitoring Organization.
3. CDM database archives management regulation.

Information on calibration of monitoring instruments

No.	Instruments	Specifications	Serial No.	Calibrated Date	Remarks
1	ADOS (Methane Analyzer)	Biogas 401	47552	16 Jan.2008/13 Jan.2009	annually calibrated as described in PDD
2	Electricity meter (high voltage)	DSSD22[3*100V 3*1.5(10)A]	S12-054996	25 Feb.2008	annually calibrated as described in PDD
			S12-049852	10 Feb.2009	annually calibrated as described in PDD, regular replacement due to calibration frequency requirements
3	Electricity meter (low voltage)	DTS371-D	88097613	22 Feb.2008	annually calibrated as described in PDD
			88315417	10 Feb.2009	annually calibrated as described in PDD, regular replacement due to calibration frequency requirements
4	Electricity meter in control room	DTS371	88139927	27 June 2008	annually calibrated as described in PDD
			88097635	17 Jun.2009	annually calibrated as described in PDD, regular replacement due to calibration frequency requirements
5	Flow meter ($F_{total,1}$)	72F2H-SAOAA13AA4AW	9C05EA02000	25 Feb.2008	annually calibrated as described in PDD
			9C05E902000	9 Feb.2009	annually calibrated as described in PDD, regular replacement due to calibration frequency requirements
6	Flow meter ($F_{total,2}$)	72F2H-SAOAA13AA4AW	9C05E702000	18 Feb. 2009	annually calibrated as described in PDD(not open for measurement)
7	Flow meter ($F_{electricity}$)	72F2H-SAOAA13AA4AW	9C05E702000	25 Feb.2008	annually calibrated as described in PDD
			9C05E802000	9 Feb.2009	annually calibrated as described in PDD, regular replacement due to calibration frequency requirements
8	Flow meter (F_{flare})	72F1F-SBOAA13AA4AW	9C015918000	25Feb. 2008	annually calibrated as described in PDD
			9C015A18000	9 Feb.2009	annually calibrated as described in PDD, regular replacement due to calibration frequency requirements
9	Pressure sensor ($P_{total,1}$)	EJA530A-DAS4N-02NN/NF1	S4H2S00486	3 Mar. 2008	annually calibrated as described in PDD
			S4H2S00487	16 Feb.2009	annually calibrated as described in PDD, regular replacement due to calibration frequency requirements
10	Pressure sensor ($P_{total,2}$)	EJA530A-DAS4N-02NN/NF1	S4H2S00486	23 Feb.2009	annually calibrated as described in PDD(not open for measurement)
11	Pressure sensor (P_{flare})	EJA530A-DAS4N-02NN/NF1	S4H2S00490	3 Mar. 2008/18 Feb.2009	annually calibrated as described in PDD
12	Pressure sensor ($P_{electricity}$)	EJA530A-DAS4N-02NN/NF1	S4H2S00488	3 Mar. 2008	annually calibrated as described in PDD
			S4H2S00489	16 Feb.2009	annually calibrated as described in PDD, regular replacement due to calibration frequency requirements

No.	Instruments	Specifications	Serial No.	Calibrated Date	Remarks
13	Temperature sensor ($T_{total,1}$)	SBWZ-2460 -240	0184755	17 Mar. 2008	annually calibrated as described in PDD
			0184753	12 Mar.2009	annually calibrated as described in PDD
		WZPKB-240	09046036	11 May 2009	annually calibrated as described in PDD, regular replacement due to calibration frequency requirements
14	Temperature sensor ($T_{total,2}$)	WZPKB-240	09046036	11 May 2009	annually calibrated as described in PDD
		SBWZ-2460 -240	0184753	12 Mar.2009	annually calibrated as described in PDD, regular replacement due to calibration frequency requirements
15	Temperature sensor ($T_{electricity}$)	SBWZ-2460 -240	0184753	17 Mar.2008	annually calibrated as described in PDD
			0184752	27 Feb.2009	annually calibrated as described in PDD, regular replacement due to calibration frequency requirements
16	Temperature sensor (T_{flare})	SBWZ-2460 -240	0184754	17 Mar. 2008	annually calibrated as described in PDD
			0184751	19 May 2008	annually calibrated as described in PDD
		WZPKB-240	09046035	11 May 2009	annually calibrated as described in PDD, regular replacement due to calibration frequency requirements
17	Temperature sensor ($T_{flare\ 1\#}$)	STT25M-0-ENO-000-000-000-00-3D	B427727937	9 Jan. 2009	annually calibrated as described in PDD
			B431758237	8 Jan. 2009	annually calibrated as described in PDD, regular replacement due to calibration frequency requirements
18	Temperature sensor ($T_{flare\ 2\#}$)	STT25M-0-ENO-000-000-000-00-3D	B431758237	8 Jan. 2009	annually calibrated as described in PDD
			b426706837	16 Feb.2009	annually calibrated as described in PDD

Monitoring results

Monitoring period covered

This is the fourth monitoring report of this project; it covers the period 0:00 01/02/2009 -24:00 30/09/2009.

Emission reductions

The calculated emission reductions amount to 173,780 tonnes CO_2e, a summary of the monitoring results is included in the Annex to this report.

Comparison of the actual emission reductions claimed in the monitoring period with the estimate in the registered PDD

This monitoring period covers eight months, the calculated emission reductions during this monitoring period is 173,780 tonnes CO2e. The actual emission reductions amount to 260,669 tonnes

CO2e per annum; while the estimate in the registered PDD is 471,619 tonnes CO2e. The actual emission reductions are less compared to the latter.

Presentation of monitoring results - spreadsheet

All monitoring data have been included in an excel worksheet. This includes:

1. Summary, this worksheet contains an overview of the calculation of emission reductions and general notes as described in Annex.

2. Calculations, it shows the calculation of emission reductions on the basis of raw data and calculation of flare efficiency based test data provided by a third accredited party.

3. Raw data, it contains the raw monitoring data recorded by project developer and the test data for flares provided by a third accredited party.

Calculation of baseline emissions, project emissions, leakage (if any) and emission reductions

No leakage effects need to be accounted under Methodology ACM0001.

The captured landfill gas is directly flared or used to produce energy and claim for part of the credits from displacing electricity from grid. Specifically, the general calculation formula for emission reduction of landfill gas project is listed as follows:

1.$ER_y = (MD_{project,y} - MD_{reg,y}) * GWP_{CH_4} + EL_y * CEF_{electricity, y}$

Where,

ER_y : emission reduction during the year “y”, in tonnes of CO_2 equivalents (tCO_2e).

$MD_{project,y}$: the amount of methane that would have been destroyed /combusted during the year “y”, in tonnes of methane (tCH_4).

$MD_{reg\,y,}$:the amount of methane that would have been destroyed/combusted during the year “y” in the absence of the Project (tCH_4).

GWP_{CH_4} : Global Warming Potential value for methane for the first commitment period is 21 $tCO_2e/t\ CH_4$.

EL_y : Net quantity of electricity exported during the year “y”, in megawatt hours (MWh).

$CEF_{electricity,y}$: CO_2 emissions intensity of the electricity displaced, in tCO_2e/MWh.This can estimated

by using either ACM0002 or AMS-I.D., if the capacity is within the small scale threshold values, when grid electricity is used or displaced.

2. $EL_y = EL_{EX,LFG} - EL_{IMP}$

Where,

$EL_{EX,LFG}$:net quantity of electricity exported during year "y", produced using landfill gas, in megawatt hours（MWh）.

EL_{IMP} : net incremental electricity import, defined as difference of project imports less any imports of electricity in the baseline, to meet project requirements, in MWh.

The electricity generated by this project has been transferred to the Southern Grid. Line loss occurred during the transference shall be borne by the power plant according to Chinese rules.

During this monitoring period, the electricity recorded by the PLC system was 24,335,800 kWh (of which the electricity exported was 24,342,320 kWh, electricity imported was 6,520 kWh); while the electricity recorded by Shenzhen Power Supply Bureau was 24,258,060.71 kWh (recorded in the invoices to the grid). That is, the electricity recorded by the internal monitoring system is more than that recorded in the invoices to the grid.

To be conservative, the electricity exported recorded in the invoices to grid during this period has been used for calculation.

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

Where,

$MD_{flare,y}$: the quantity of methane destroyed by flaring （tCH_4/year）.

$MD_{electricity,y}$: the quantity of methane destroyed by power generation （tCH_4/year）.

4. $MD_{flare,y} = LFG_{flare,y} * W_{CH_4} * D_{CH_4} * FE$

Where,

$LFG_{flare,y}$: the quantity of landfill gas flared during the year "y" measured in cubic meters (m^3).

$W_{CH4,y}$: the average methane fraction of the landfill gas as measured during the year and expressed as a fraction (m^3 CH_4 / m^3 LFG) .

D_{CH4} : the methane density expressed in tonnes of methane per cubic meter of methane (tCH_4/m^3CH_4).

FE : the flare efficiency (the fraction of the methane destroyed).

As per the Annex 13 to EB48 meeting “GUIDELINES TO CALCULATE THE FRACTION OF METHANE IN THE LANDFILL GAS FROM PERIODICAL MEASUREMENTS”, the methane fraction is calculated as follows:

(1) Calculate sample mean (μ).

$$\mu_{WCH4,y} = \frac{\sum_{m=1}^{n_m} W_{CH4,m,y}}{n_m}$$

Where:

$\mu_{WCH4,y}$ = Mean of the fraction of methane in the landfill gas in year *y* (m^3CH_4/m^3 LFG)

$W_{CH4,m,y}$ = Monitored fraction of methane in the landfill gas in measurement *m* in year *y* (m^3CH_4/m^3 LFG)

n_m = Number of measurements *m* in year *y* (minimum is 4)

The measurement is hourly taken for Xiaping project. The n_m amounts to 5739, and the $\mu_{WCH4,y}$ is calculated to 57.60 as per the $W_{CH4,m,y}$ (refer to the worksheet) monitored and n_m.

(2) Calculate the sample standard deviation (σ).

$$\sigma_{WCH4,y} = \sqrt{\frac{\sum_{m=1}^{n_m} (W_{CH4,m,y} - \mu_{CH4,y})^2}{n_m - 1}}$$

Where:

$\sigma_{WCH4,y}$ = Standard deviation of the fraction of methane in the landfill gas in year *y* (m^3CH_4/m^3 LFG)

Use the value calculated in equation step (1), the $W_{CH4,m,y}$ monitored and n_m, to calculate the $\sigma W_{CH4,y}$ as 2.45 during this monitoring period.

(3) Calculate the 95% confidence interval.

$$\mu_{WCH4,y} - t \cdot \frac{\sigma_{WCH4,y}}{\sqrt{n_m}} \leq W_{CH4,y} \leq \mu_{WCH4,y} + t \cdot \frac{\sigma_{WCH4,y}}{\sqrt{n_m}}$$

Where:

t = Value from standard *t* distribution for a confidence level of 95% with degrees of freedom n_{m-1}

When the confidence level is 95% and n_m-1=5738, t concludes to 1.96.

(4) Use the lower bound of the 95% confidence interval obtained below to ensure conservativeness.

$$W_{CH4,lb,y} = \mu_{WCH4,y} - t \cdot \frac{\sigma_{WCH4,y}}{\sqrt{n_m}}$$

Where:

$W_{CH4,lb,y}$ = Lower bound of the 95% confidence interval of fraction of methane in the landfill gas (m^3CH_4/m^3 LFG)

As per the data monitored and values concluded from Step (1）--(4), the $W_{CH4,lb,y}$ is calculated to 57.54 during this period.

(5) The value of $W_{CH4,lb,y}$ estimated in equation 4 should be used in the methodology as the final value for fraction of methane in the landfill gas during this monitoring period.

The efficiency of the two flares varies with each other. If only one flare is operating during a specific period, its efficiency which was determined by the accredited party is used for calculation of $LFG_{flare, y}$; if both are operating, the lower efficiency will be adopted for conservativeness.

This project applies methodologies ACM0001 (version 04 of 28/7/06), which requires "the project participant shall measure and quantify the efficiency of the flare on a yearly basis"(P3). Since the methodologies ACM0001 (version 5) was issued prior to monitoring of this project, the Annex 13 to EB28 meeting to which titled "Methodological Tool to determine project emissions from flaring gases containing methane" gives a detailed description on efficiency monitoring and calculation method. This project therefore has applied the monitoring period specified in version 4 and referred to Annex 13 to EB28 meeting for the parameters monitored and calculation.

This monitoring period requires the second and third test for flare 1# as well as the second test for flare 2#. The second and the third test for efficiency of flare 1# had been made respectively by Centre Testing International (ShenZhen) Corporation in June 2008 and June 2009; while the second test for flare 2# was made in January 2009. .

The temperature of flare operation shall be maintained no lower than 500°C; to be conservative, should the temperature is lower than 500°C; the emission reduction resulted from methane destruction of an hour prior to and after the recorded hour will be neglected.

The detailed test data and determination method shall refer to the annex to this report.

Calculation Steps

Calculation methodology for emission reduction from Xiaping LFG Project took place in the following steps:

1. Collect the recorded data of LFG flows (LFG_{total}, LFG_{flare}, and $LFG_{electricity}$) during the monitoring period which is normally recorded per hour in m^3.

2. Collect the recorded data of LFG temperature and pressure during the monitoring period which is normally recorded per hour in °C and KPa.
3. Determining the methane density per hour with the average of temperature and pressure recorded at the hour "*h*" and the previous hour.
4. Calculating the confidence interval of the methane density at 95% confidence level with the methane density concluded from step 3, adopting the lower bound as the methane density during this monitoring period.
5. The $LFG_{flare, y}$ recorded at the last hour minus the $LFG_{flare, y}$ recorded at the first hour, further minus the difference of the cumulative flow between the hour prior to the hour *h* and the hour after the hour *h* when the operation temperature is lower than 500°C, to get the total $LFG_{flare, y}$ during this monitoring period.
6. The $LFG_{electricity, y}$ recorded at the last hour minus the $LFG_{electricity, y}$ recorded at the first hour to get the total $LFG_{electricity, y}$ during this monitoring period.
7. Collect the recorded data of methane fraction in the landfill gas (W_{CH4}) during the monitoring period, which are normally recorded per hour in vol %.
8. As per Annex 13 of EB 48 meeting, calculating the confidence interval of the methane fraction at 95% confidence level with the recorded data from step 7, adopting the lower bound as the methane fraction during this monitoring period.
9. Multiply the result of step 5 with the lower bound of methane fraction vol% get m^3 of CH_4 destroyed by flare during this monitoring.
10. Then multiply with the lower bound of methane density (D_{CH4}) and further multiply with FE to get tonnes of CH_4 destroyed by flare during this monitoring period.
11. Multiply the result of step 6 with the lower bound of methane fraction vol % to get m^3 of CH_4 destroyed by power generation during this monitoring period.
12. Then multiply with the lower bound of methane density (D_{CH4}) to get tonnes of CH_4 during this monitoring period destroyed by power generation.
13. Add the subtotals of step 10 and 12 to get tonnes of CH_4 destroyed by generation and flaring during this monitoring period.
14. Apply the adjustment factor AF (%) to calculate tonnes of CH_4 destroyed during this monitoring period in the absence of the project.

15. The results obtained by subtracting the subtotal of step14 from 13 then multiply with 21 (Global warming potential of CH_4, GWP_{CH4}) to get the amount of emission reductions destroyed by the project activity during this monitoring period, in tonnes of CO_2 equivalent.
16. Collect the recorded data of net electricity exported by electricity meter during monitoring period which is normally recorded per hour in MWh. The data recorded at the last hour minus that recorded at the first hour to get the total electricity generated during this monitoring period.
17. Collect the recorded data of net incremental electricity imported by electricity meter during monitoring period which is normally recorded per hour in KWh. The data recorded at the last hour minus that recorded at the first hour to get the total electricity consumed by the project during this monitoring period.
18. The result obtained by subtracting the subtotal of step 17 from 16 (with same unit)multiply with the emissions factor for displaced power to get the emission reduction attributable to the displacement of grid electricity by the Project Activity (here: 0.608 tCO_2/MWh).
19. Add the subtotals of step 15 and 18 to get emission reductions during this monitoring period, in tonnes of CO_2 equivalent.

ANNEX

Xiaping Landfills Gas Collection and Utilization Project

Monitoring Report CDM 0887-MR04 Monitoring Period: 0:00 01/02/2009 -24:00 30/09/2009.

Shenzhen Lisai Development Co. Ltd., 31 May 2010.

Emission factors, IPCC default values and other reference values

Items		Data	Unit	Notes
Global Warming Potential of CH_4	GWP_{CH4}	21		ACM0001
Methane density	D_{CH_4}	0.0007168	tCH_4/Nm^3	ACM0001
CO_2 emissions intensity of the electricity displaced	$CEF_{electricity,y}$	0.608	tCO_2/MWh	as validated in the PDD

Parameters required to be monitored and reported

Activities		Data	Sources	
Total Landfill gas to Flare	$LFG_{flare, total}$	5,200,373	m^3	worksheets
Valid Landfill gas to Flare	$LFG_{flare, valid}$	4,989,418	m^3	Worksheets, total flow minus those flow recorded when the flare operates at a temperature lower than 500°C
Landfill gas to Electricity	$LFG_{electricity}$	15,233,006	m^3	worksheets
Landfill gas to heat	$LFG_{thermal}$	-	m^3	Not applicable
Total landfill gas (pipe one)	$LFG_{total,1}$	20,573,374	m^3	worksheets
Total landfill gas (pipe two)	$LFG_{total,2}$	0	m^3	Not work during this monitoring period
Quantity of electricity exported (monitored by PLC)	$EL_{EX,LFG}$	24,342.32	MWh	Worksheets (electricity consumed by the project counted)
Electricity import (high voltage electricity consumed by power plant monitored by PLC)	$EL_{IMP,electricity,H}$	6.52	MWh	worksheets
Electricity import (low voltage electricity consumed by power plant monitored by PLC)	$EL_{IMP,electricity,L}$	0.00	MWh	worksheets
Electricity import(low voltage electricity consumed by collection and flaring system monitored by PLC)	$EL_{IMP,flare}$	303.92	MWh	worksheets
Quantity of electricity exported (recorded in invoices to grid)	$EL_{EX,LFG}$	24,258.06	MWh	Invoices, high voltage electricity consumed by power plant has been deducted($EL_{IMP,electricity,H}$）
Electricity import (collection and flaring system recorded in invoices)	$EL_{IMP,flare}$	304.72	MWh	Invoices
Electricity import (consumed by power plant recorded in invoices)	$EL_{IMP,L}$	0.00	MWh	Invoices
Adjustment Factor	AF	0	%	No changes to regulatory requirements relating to LFG projects, so AF remains the same as validated PDD

Operating records for generator 1#	$T_{1,G}$	4926.24	Hours	worksheets
Operating records for generator 2#	$T_{2,G}$	1452.00	Hours	worksheets
Operating records for generator 3#	$T_{3,G}$	4451.76	Hours	worksheets
Operating records for generator 4#	$T_{4,G}$	4860.72	Hours	worksheets
Operating records for generator 5#	$T_{5,G}$	5194.56	Hours	worksheets
Operating records for generator 6#	$T_{6,G}$	5126.88	Hours	worksheets
Operating records for flares	$T_{1,F}$	1392.00	Hours	worksheets
	$T_{2,F}$	4274.88		

The electricity generated by this project had been transferred to the Southern Grid. Electricity loss occurred during the transference shall be borne by the power plant according to the relevant Chinese rules; the net electricity exported monitored during this project is more than that recorded in the invoices to the grid. To be conservative, the net electricity exported recorded in invoices during this period has been applied, i.e. 24,258.06MWh.

Two electricity meters are installed in this project to measure the electricity imported from the grid. One is installed in power plant to measure the electricity consumed when the generators fail to work and the other one is installed in the control room to measure the electricity consumed by the collection and flaring system. However, the amount recorded in invoices is more than that measured during this period. To be conservative, the amount recorded in invoices shall be applied in this period.

Calculated values

Items		**Data**	**Unit**	**Notes**
Flare combustion efficiency	$FE_{1,Second}$	99.215	%	Measured and quantified on a yearly basis
	$FE_{1,Third}$	95.100	%	
	$FE_{2,Second}$	99.690	%	
Methane Fraction	W_{CH4}	57.54	tCH_4	Lower bound of the 95% confidence interval
Methane Density	D_{CH4}	0.0006577	tCH_4	Lower bound of the 95% confidence interval

Methane destroyed by flaring	MD_{flare}	1,817.68	tCH_4	Based on methane fraction calculation at normal conditions (methane destroyed at a temperature lower than 500°C neglected)
Methane destroyed as fuel by LFG power generation	$MD_{electricity}$	5,764.03	tCH_4	Based on methane fraction calculation at normal conditions
Methane destroyed as fuel by LFG thermal generation	$MD_{thermal}$	-	tCH_4	not applicable
Methane destruction	$MD_{project}$ *	7,581.71	tCH_4	Based on methane fraction calculation at normal conditions
Methane destruction in absence of project	MD_{reg}	0.00	tCH_4	AF=0
Net electricity generated	EL_y	23,953.34	MWh	The amount of exported electricity recorded in the invoices to grid minus low voltage electricity recorded in the invoices
Emission avoidance by electricity displaced	EL_y*$CEF_{electricity}$	14,563.63	tCO_2e	claimed by the project developer in the PDD
Total emission reduction	ER_y	173,780	tCO_2e	Based on daily methane fraction calculation

*As set out the registered PDD (v7) of Xiaping project, the methodology ACM0001 (v4) is adopted in this project. It was set out that "the fraction of methane in the landfill gas ($w_{CH4,y}$) should be measured with a continuous analyzer or, alternatively, with periodical measurements, at a 95% confidence level, using calibrated portable gas meters and taking statistically valid number of samples and…in the same frequency"(P7).

The methane density is determined per hour in this project. The confidence interval of methane density at the 95% confidence level is calculated according to all data determined per hour, and the lower bound of the confidence interval is adopted as the methane density during this monitoring period.

The methane fraction is hourly monitored in this project. The confidence interval of methane fraction

at the 95% confidence level is calculated as per all the monitored data, and the lower bound of the confidence interval is adopted as the methane fraction during this monitoring period.

All CER Verifications

Monitoring period	**Emission reductions $ER_y(tCO_2e)$**
0:00 01/02/2009 -24:00 30/09/2009	173,780

Test and Determination of Flare Efficiency

According to Annex 13 to EB28 meeting and actual measurement capacity, the specific parameters monitored are listed as follows:

Residual gas: flow (volumetric flow rate of the residual gas in wet basis at non-standard conditions), pressure, temperature, oxygen content (volumetric fraction in wet basis), methane content (mass fraction in wet basis at the non-standard conditions), moisture (volumetric fraction);
Exhaust gas: oxygen content (volumetric fraction in wet basis), methane content (mass fraction in wet basis at the non-standard conditions), moisture (volumetric fraction), pressure and temperature.

The following equations will be applied in this project for determining of the flare efficiency as per Annex 13 to EB 28 meeting：

STEP 1. Determination of the mass flow rate of the residual gas that is flared

This step calculates the residual gas mass flow rate in each hour *h*, based on the volumetric flow rate and the density of the residual gas. The density of the residual gas is determined based on the volumetric fraction of all components in the gas.

$$FM_{RG,h} = \rho_{RG,n,h} \times FV_{RG,h}$$

Where:

$FM_{RG,h}$: Mass flow rate of the residual gas in hour *h*, kg/h.

$\rho_{RG,n,h}$: Density of the residual gas at normal conditions in hour *h*, kg/m^3

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

Only Volumetric flow rate $FV_{RG,h,\ wet,\ non\text{-}standard}$ in wet basis at non-standard conditions, volumetric fraction of the moisture $fv_{H2O,\ h}$, Pressure P and Temperature T of the residual gas can be measured in actual sense.

Therefore, it is necessary to convert the volumetric flow rate in wet basis at non-standard conditions into that in wet basis at normal conditions by referring to the following equation:

$$\mathbf{FV_{RG,h,wet,\ normal}} = \mathbf{FV_{RG,h,\ wet,\ non\text{-}standard}} \times (P + \mathbf{Pn}/1000000) \times \mathbf{Tn}/(\mathbf{Pn}/1000000)/(\mathbf{Tn} + \mathbf{T})$$

Then convert the volumetric flow rate concluded above into volumetric flow rate in dry basis at normal conditions as follows:

$$\mathbf{FV_{RG,h}} = \mathbf{FV_{RG,h,\ wet,\ normal}} \times (\mathbf{1 - fv_{H2O,\ h}})$$

And:

$$\rho_{RG,n,h} = Pn \div (Ru \div MM_{RG,h} \times Tn)$$

Where:

$\rho_{RG,n,h}$: Density of the residual gas at normal conditions in hour *h*, kg/m3

P_n : Atmospheric pressure at normal conditions (101 325), Pa.

R_u : Universal ideal gas constant (8 314), Pa.m3/kmol.K

$MM_{RG,h}$: Molecular mass of the residual gas in hour *h*, kg/kmol.

T_n : Temperature at normal conditions (273.15), K.

And,

$$MM_{RG,h} = fv_{CH4,h} \times MM_{CH4} + fv_{O2,h} \times MM_{O2} + fv_{N2,h} \times MM_{N2}$$

Where,

$MM_{RG,h}$: Molecular mass of the residual gas in hour *h*, kg/kmol.

$fv_{i,h}$: Volumetric fraction of component *i* in the residual gas in the hour *h*.

MM_i : Molecular mass of residual gas component *i* kg/kmol， CH_4: 16.04, O_2: 32.00, N_2: 28.02.

I: The components CH_4, O_2, N_2.

Only the volumetric fraction of the moisture $fv_{H2O,\ h,}$ volumetric fraction of the oxygen in wet basis $fv_{O2,\ h,\ wet}$ mass fraction of methane in wet basis at non-standard conditions $fv_{CH4,\ h,mass,\ wet,\ non\text{-}standard}$ of the

residual gas can be measured.

Calculating the volumetric fraction of methane in wet basis at normal conditions by referring to the mass fraction of methane in the same basis at non-standard conditions in the residual gas as follows:

$$fv_{CH4,h,wet,normal} = fv_{CH4,h,mass,wet,non\text{-}standard}/1000/16 \times 22.4/1000 \times Pn/1000000 \times (Tn+T)/Tn/1/(Pn/1000000+P)$$

Calculating the volumetric fraction of methane in dry basis at normal conditions by referring to the volumetric fraction of methane in wet basis at normal conditions and the volumetric fraction of moisture in residual gas as follows:

$$fv_{CH4,h} = fv_{CH4,h,wet,normal}/(1-fv_{H2O,h})$$

Calculating the volumetric fraction of oxygen in dry basis in residual gas by referring to the volumetric fraction of oxygen in wet basis and the volumetric fraction of moisture in residual gas as follows:

$$fv_{O2,h} = fv_{O2,h,wet}/(1-fv_{H2O,h})$$

This project considers the difference in residual gas to 100% as being nitrogen, and the volumetric fraction of nitrogen can be concluded as follows:

$$fv_{N2,h} = 1-(fv_{CH4,h} + fv_{O2,h})$$

STEP 2. Determination of the mass fraction of carbon, hydrogen, oxygen and nitrogen in the residual gas

Determine the mass fractions of carbon, hydrogen, oxygen and nitrogen in the residual gas, calculated from the volumetric fraction of each component *i* in the residual gas, as follows:

$$fm_{j,h} = \frac{\sum_i fv_{i,h} \cdot AM_j \cdot NA_{j,i}}{MM_{RG,h}}$$

Where,

$f_{mj,h}$: Mass fraction of element *j*(CH_4, O_2,N_2) in the residual gas in hour *h*.

$f_{vi,h}$: Volumetric fraction of component *i* in the residual gas in hour *h*.

AM_j: Atomic mass of element *j*(CH_4, O_2,N_2),kg/kmol.

$NA_{j,i}$: Number of atoms of element *j* in component *i*.

$MM_{RG,h}$: Molecular mass of the residual gas in hour *h*, kg/kmol.

j: The elements carbon, hydrogen, oxygen and nitrogen.

i: The components CH_4, O_2, N_2.

STEP 3. Determination of the volumetric flow rate of the exhaust gas on a dry basis

Determine the average volumetric flow rate of the exhaust gas in each hour *h* based on a stoichiometric calculation of the combustion process, which depends on the chemical composition of the residual gas, the amount of air supplied to combust it and the composition of the exhaust gas, as follows:

$TV_{n,FG,h} = V_{n,FG,h} \times FM_{RG,h}$

Where,

$TV_{n,FG,h}$: Volumetric flow rate of the exhaust gas in dry basis at normal conditions in hour *h*, m^3/h.

$V_{n,FG,h}$: Residual gas Volume of the exhaust gas of the flare in dry basis at normal conditions per kg of residual gas in hour *h*, m^3/kg.

$FM_{RG,h}$: Mass flow rate of the residual gas in the hour *h*, kg residual gas/h.

$V_{n,FG,h} = V_{n,CO2,h} + V_{n,O2,h} + V_{n,N2,h}$

Where,

$V_{n,FG,h}$: Volume of the exhaust gas of the flare in dry basis at normal conditions per kg of

residual gas in the hour *h,* m^3/kg residual gas.

$V_{n,CO2,h}$: Quantity of CO_2 volume free in the exhaust gas of the flare at normal conditions per kg of residual gas in the hour *h,* m^3/kg residual gas.

$V_{n,N2,h}$: Quantity of N_2 volume free in the exhaust gas of the flare at normal conditions per kg of residual gas in the hour *h* m^3/kg residual gas.

$V_{n,O2,h}$: Quantity of O_2 volume free in the exhaust gas of the flare at normal conditions per kg of residual gas in the hour *h,* m^3/kg residual gas.

$V_{n,O2,h} = n_{O2,h} \times MV_n$

Where,

$V_{n,O2,h}$: Quantity of O_2 volume free in the exhaust gas of the flare at normal conditions per kg of residual gas in the hour *h,* m^3/kg residual gas.

$n_{O2,h}$: Quantity of moles O_2 in the exhaust gas of the flare per kg residual gas flared in hour *h*, kmol/kg residual gas.

MV_n: Volume of one mole of any ideal gas at normal temperature and pressure (22.4 L/mol), m^3/kmol.

$$V_{n,N2,h} = MV_n * \left\{ \frac{fm_{N,h}}{200 AM_N} + \left(\frac{1 - MF_{o2}}{MF_{o2}} \right) * \left[F_h + n_{o2,h} \right] \right\}$$

Where,

$V_{n,N2,h}$: Quantity of N_2 volume free in the exhaust gas of the flare at normal conditions per kg of residual gas in the hour *h,* m^3/kg residual gas

M_{Vn} : Volume of one mole of any ideal gas at normal temperature and pressure (22.4 m^3/Kmol)

$fm_{N,h}$: Mass fraction of nitrogen in the residual gas in the hour *h*

AM_n : Atomic mass of nitrogen, kg/kmol.

MF_{O2} : O_2 volumetric fraction of air.

F_h : Stochiometric quantity of moles of O_2 required for a complete oxidation of one kg residual gas in hour *h*, kmol/kg residual gas

$n_{O2,h}$: Quantity of moles O_2 in the exhaust gas of the flare per kg residual gas flared in hour *h,* kmol/kg residual gas

$$V_{n,CO2,h} = \frac{fm_{C,h}}{AM_C} * MV_n$$

Where,

$V_{n,CO2,h}$: Quantity of CO_2 volume free in the exhaust gas of the flare at normal conditions per kg of residual gas in the hour *h,* m3/kg residual gas.

$fm_{C,h}$: Mass fraction of carbon in the residual gas in the hour *h.*

AM_C : Atomic mass of carbon, kg/kmol.

MV_n : Volume of one mole of any ideal gas at normal temperature and pressure (22.4 m3/kmol).

$$n_{O2,h} = \frac{t_{O2,h}}{\left(1-\left(t_{O2,h}/MF_{O2}\right)\right)} \times \left[\frac{fm_{C,h}}{AM_C} + \frac{fm_{N,h}}{2AM_N} + \left(\frac{1-MF_{O2}}{MF_{O2}}\right) \times F_h\right]$$

Where,

$n_{O2,h}$: Quantity of moles O_2 in the exhaust gas of the flare per kg residual gas flared in hour *h,* kmol/kg residual gas

$t_{O2,h}$: Volumetric fraction of O_2 in the exhaust gas in the hour *h*

MF_{O2}: Volumetric fraction of O_2 in the air (0.21)

F_h : Stochiometric quantity of moles of O_2 required for a complete oxidation of one kg residual gas in hour *h,* kmol/kg residual gas

$fm_{j,h}$: Mass fraction of element *j* in the residual gas in hour *h* (from equation 4)

AM_j : Atomic mass of element *j*, kg/kmol

j : The elements carbon (index C) and nitrogen (index N)

Only volumetric fraction of oxygen in wet basis and volumetric fraction moisture in exhaust gas can be measured, and then concludes the volumetric fraction of the oxygen in dry basis as follows:

$t_{O2,h} = t_{O2,h,\ wet)} / (1 - t_{H2O,h})$

$$F_h = \frac{fm_{C,h}}{AM_C} + \frac{fm_{H,h}}{4AM_H} + \frac{fm_{O,h}}{2AM_O}$$

Where,

F_h : Stoichiometric quantity of moles of O_2 required for a complete oxidation of one kg residual gas in hour *h,* kmol O_2/kg residual gas

$fm_{j,h}$: Mass fraction of element *j* in the residual gas in hour *h*

AM_j: Atomic mass of element *j,* kg/kmol

j : The elements carbon (index C), hydrogen (index H) and oxygen (index O)

STEP 4. Determination of methane mass flow rate in the exhaust gas on a dry basis

This step is only applicable if the methane combustion efficiency of the flare is continuously monitored.

The mass flow of methane in the exhaust gas is based on the volumetric flow of the exhaust gas and the measured concentration of methane in the exhaust gas, as follows:

$$TM_{FG,h} = \frac{TV_{n,FG,h} * fv_{CH4,h}}{1000000}$$

Where,

$TM_{FG,h}$: kg/h Mass flow rate of methane in the exhaust gas of the flare in dry basis at normal conditions in the hour *h*

$TV_{n,FG,h}$: Volumetric flow rate of the exhaust gas in dry basis at normal conditions in hour *h,* m^3/h exhaust gas.

$fv_{CH4,FG,h}$: Concentration of methane in the exhaust gas of the flare in dry basis at normal conditions in hour *h*, mg/m^3.

$t_{H2O,h}$: Volumetric fraction of H_2O in the exhaust gas in the hour *h*

Only mass fraction of methane in wet basis at non-standard conditions, temperature and pressure in exhaust gas can be measured in actual sense, and then concludes the mass fraction of methane in dry basis at normal conditions in exhaust gas as follows:

$fv_{CH4,FG,h} = fv_{CH4,FG,h,wet,\ non\text{-}standard} * Pn/1000000*(T+Tn)/Tn/1/(Pn/1000000+P)/(1-t_{H2O,h})$

STEP 5. Determination of methane mass flow rate in the residual gas on a dry basis

The quantity of methane in the residual gas flowing into the flare is the product of the volumetric flow rate of the residual gas ($FV_{RG,h}$), the volumetric fraction of methane in the residual gas($fv_{CH4,RG,h}$) and the density of methane ($\rho_{CH4,n,h}$) at the same reference conditions (normal conditions and dry or wet basis).

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

Where,

$TM_{RG,h}$: Mass flow rate of methane in the residual gas in the hour *h,* 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 (0.716), kg/m^3

STEP 6. Determination of the hourly flare efficiency

The determination of the hourly flare efficiency depends on the operation of flare (e.g. temperature), the type of flare used (open or enclosed) and, in case of enclosed flares, the approach selected by project participants to determine the flare efficiency (default value or continuous monitoring).

Since the **enclosed flare is installed in this project and the efficiency of the flare is measured and quantified on a yearly basis,** the flare efficiency in the hour *h* ($\eta_{flare,h}$) is thus

calculated as follows:

$$\eta_{flare,h} = 1 - \frac{TM_{FG,h}}{TM_{RG,h}}$$

Where:

$\eta_{flare,h}$: Flare efficiency in the hour h

$TM_{FG,h}$: Methane mass flow rate in exhaust gas averaged in a period of time t, kg/h (hour, two months or year)

$TM_{RG,h}$: Mass flow rate of methane in the residual gas in the hour, kg/h

5. $MD_{electricity,y} = LFG_{electricity,y} * W_{CH_4} * D_{CH_4}$

Where,

$MD_{electricity,y}$: the quantity of methane destroyed by generation of electricity（tCH_4/year）.

$LFG_{electricity,y}$: the quantity of landfill gas used for power generation during the year “y” measured in cubic meters (m^3).

6. $MD_{reg} = MD_{project} * AF$

Where,

AF: Adjustment Factor, as defined in PDD

Second Test for Efficiency of Flare 1# in June 2008

Operation Temperature	Points	Variable	Value	Average
500 °C	Sample 1# in residual gas	CH_4	4.1×10^5mg/m^3	4.2×10^5mg/m^3
	Sample 2# in residual gas	CH_4	4.1×10^5mg/m^3	
	Sample 3# in residual gas	CH_4	4.5×10^5mg/m^3	
	Sample 1# in residual gas	O_2	0.1%（v/v）	0.1%（v/v）
	Sample 2# in residual gas	O_2	0.1%（v/v）	
	Sample 3# in residual gas	O_2	0.1%（v/v）	
	Sample 1# in residual gas	H_2O	5.6%（v/v）	5.4%（v/v）
	Sample 2# in residual gas	H_2O	4.6%（v/v）	
	Sample 3# in residual gas	H_2O	5.9%（v/v）	
	Sample 1# in residual gas	temperature	45.1°C	45.4°C
	Sample 2# in residual gas	temperature	45.9°C	
	Sample 3# in residual gas	temperature	45.3°C	
	Sample 1# in residual gas	pressure	2.54Kpa	2.54Kpa
	Sample 2# in residual gas	pressure	2.54Kpa	

	Sample 3# in residual gas	pressure	2.54Kpa	
	Sample 1# in residual gas	flow	442m3/h	460m3/h
	Sample 2# in residual gas	flow	468m3/h	
	Sample 3# in residual gas	flow	470m3/h	
	Sample 1# in exhaust gas	CH_4	29.0mg/m3	33.5mg/m3
	Sample 2# in exhaust gas	CH_4	40.6mg/m3	
	Sample 3# in exhaust gas	CH_4	28.3mg/m3	
	Sample 4# in exhaust gas	CH_4	36.1mg/m3	
	Sample 1# in exhaust gas	O_2	17.5%（v/v）	17.5%（v/v）
	Sample 2# in exhaust gas	O_2	17.9%（v/v）	
	Sample 3# in exhaust gas	O_2	17.1%（v/v）	
	Sample 4# in exhaust gas	O_2	17.5%（v/v）	
	Sample 1# in exhaust gas	H_2O	9.6%（v/v）	9.8%（v/v）
	Sample 2# in exhaust gas	H_2O	10.1%（v/v）	
	Sample 3# in exhaust gas	H_2O	9.7%（v/v）	
	Sample 4# in exhaust gas	H_2O	9.7%（v/v）	
	Sample 1# in exhaust gas	temperature	482°C	482°C
	Sample 2# in exhaust gas	temperature	482°C	
	Sample 3# in exhaust gas	temperature	479°C	
	Sample 4# in exhaust gas	temperature	486°C	
	Sample 1# in exhaust gas	pressure	0.131Kpa	0.130Kpa
	Sample 2# in exhaust gas	pressure	0.134Kpa	
	Sample 3# in exhaust gas	pressure	0.128Kpa	
	Sample 4# in exhaust gas	pressure	0.128Kpa	
700 °C	Sample 1# in residual gas	CH_4	4.3×10^5mg/m3	4.0×10^5mg/m3
	Sample 2# in residual gas	CH_4	4.0×10^5mg/m3	
	Sample 3# in residual gas	CH_4	3.7×10^5mg/m3	
	Sample 1# in residual gas	O_2	0.1%（v/v）	0.1%（v/v）
	Sample 2# in residual gas	O_2	0.1%（v/v）	
	Sample 3# in residual gas	O_2	0.2%（v/v）	
	Sample 1# in residual gas	H_2O	4.9%（v/v）	4.4%（v/v）
	Sample 2# in residual gas	H_2O	3.9%（v/v）	
	Sample 3# in residual gas	H_2O	4.4%（v/v）	
	Sample 1# in residual gas	temperature	44.7°C	44.7°C
	Sample 2# in residual gas	temperature	44.7°C	
	Sample 3# in residual gas	temperature	44.6°C	
	Sample 1# in residual gas	pressure	2.73Kpa	2.73Kpa
	Sample 2# in residual gas	pressure	2.51Kpa	
	Sample 3# in residual gas	pressure	2.94Kpa	
	Sample 1# in residual gas	flow	446m3/h	450m3/h
	Sample 2# in residual gas	flow	443m3/h	
	Sample 3# in residual gas	flow	460m3/h	

	Sample 1# in exhaust gas	CH_4	38.2mg/m3	18.3mg/m3
	Sample 2# in exhaust gas	CH_4	15.1mg/m3	
	Sample 3# in exhaust gas	CH_4	14.4mg/m3	
	Sample 4# in exhaust gas	CH_4	5.32mg/m3	
	Sample 1# in exhaust gas	O_2	15.7% (v/v)	15.3% (v/v)
	Sample 2# in exhaust gas	O_2	15.3% (v/v)	
	Sample 3# in exhaust gas	O_2	15.1% (v/v)	
	Sample 4# in exhaust gas	O_2	15.0% (v/v)	
	Sample 1# in exhaust gas	H_2O	11.1% (v/v)	13.2% (v/v)
	Sample 2# in exhaust gas	H_2O	14.3% (v/v)	
	Sample 3# in exhaust gas	H_2O	14.3% (v/v)	
	Sample 4# in exhaust gas	H_2O	13.2% (v/v)	
	Sample 1# in exhaust gas	temperature	706°C	703°C
	Sample 2# in exhaust gas	temperature	703°C	
	Sample 3# in exhaust gas	temperature	699°C	
	Sample 4# in exhaust gas	temperature	705°C	
	Sample 1# in exhaust gas	pressure	0.100Kpa	0.100Kpa
	Sample 2# in exhaust gas	pressure	0.101Kpa	
	Sample 3# in exhaust gas	pressure	0.099Kpa	
	Sample 4# in exhaust gas	pressure	0.100Kpa	
770 °C	Sample 1# in residual gas	CH_4	4.4×105mg/m3	4.2×105mg/m3
	Sample 2# in residual gas	CH_4	4.2×105mg/m3	
	Sample 3# in residual gas	CH_4	3.9×105mg/m3	
	Sample 1# in residual gas	O_2	0.2% (v/v)	0.2% (v/v)
	Sample 2# in residual gas	O_2	0.2% (v/v)	
	Sample 3# in residual gas	O_2	0.2% (v/v)	
	Sample 1# in residual gas	H_2O	4.5% (v/v)	3.5% (v/v)
	Sample 2# in residual gas	H_2O	3.0% (v/v)	
	Sample 3# in residual gas	H_2O	2.9% (v/v)	
	Sample 1# in residual gas	temperature	43.2°C	43.2°C
	Sample 2# in residual gas	temperature	43.4°C	
	Sample 3# in residual gas	temperature	43.0°C	
	Sample 1# in residual gas	pressure	3.94Kpa	3.90Kpa
	Sample 2# in residual gas	pressure	3.83Kpa	
	Sample 3# in residual gas	pressure	3.94Kpa	
	Sample 1# in residual gas	flow	470m3/h	480m3/h
	Sample 2# in residual gas	flow	474m3/h	
	Sample 3# in residual gas	flow	494m3/h	
	Sample 1# in exhaust gas	CH_4	7.54mg/m3	8.66mg/m3
	Sample 2# in exhaust gas	CH_4	7.11mg/m3	
	Sample 3# in exhaust gas	CH_4	7.39mg/m3	
	Sample 4# in exhaust gas	CH_4	12.6mg/m3	

	Sample 1# in exhaust gas	O_2	10.9%（v/v）	10.4%（v/v）
	Sample 2# in exhaust gas	O_2	11.3%（v/v）	
	Sample 3# in exhaust gas	O_2	10.1%（v/v）	
	Sample 4# in exhaust gas	O_2	9.41%（v/v）	
	Sample 1# in exhaust gas	H_2O	8.9%（v/v）	7.8%（v/v）
	Sample 2# in exhaust gas	H_2O	8.0%（v/v）	
	Sample 3# in exhaust gas	H_2O	7.1%（v/v）	
	Sample 4# in exhaust gas	H_2O	7.1%（v/v）	
	Sample 1# in exhaust gas	temperature	762°C	770°C
	Sample 2# in exhaust gas	temperature	777°C	
	Sample 3# in exhaust gas	temperature	770°C	
	Sample 4# in exhaust gas	temperature	772°C	
	Sample 1# in exhaust gas	pressure	0.098Kpa	0.098Kpa
	Sample 2# in exhaust gas	pressure	0.099Kpa	
	Sample 3# in exhaust gas	pressure	0.098Kpa	
	Sample 4# in exhaust gas	pressure	0.098Kpa	

Third Test for Efficiency of Flare 1# in June 2009

Operation Temperature	Points	Variable	Value	Average
500 °C	Sample 1# in residual gas	CH_4	5.08×10^5mg/m^3	4.72×10^5mg/m^3
	Sample 2# in residual gas	CH_4	4.38×10^5mg/m^3	
	Sample 3# in residual gas	CH_4	4.69×10^5mg/m^3	
	Sample 1# in residual gas	O_2	0.15%（v/v）	0.14%（v/v）
	Sample 2# in residual gas	O_2	0.13%（v/v）	
	Sample 3# in residual gas	O_2	0.13%（v/v）	
	Sample 1# in residual gas	H_2O	4.2%（v/v）	4.2%（v/v）
	Sample 2# in residual gas	H_2O	3.9%（v/v）	
	Sample 3# in residual gas	H_2O	4.5%（v/v）	
	Sample 1# in residual gas	temperature	50.1°C	48.2°C
	Sample 2# in residual gas	temperature	49.5°C	
	Sample 3# in residual gas	temperature	45.1°C	
	Sample 1# in residual gas	pressure	10.45Kpa	10.37Kpa
	Sample 2# in residual gas	pressure	10.23Kpa	
	Sample 3# in residual gas	pressure	10.43Kpa	
	Sample 1# in residual gas	flow	500m^3/h	500m^3/h
	Sample 2# in residual gas	flow	500m^3/h	
	Sample 3# in residual gas	flow	500m^3/h	
	Sample 1# in exhaust gas	CH_4	3.53×10^2mg/m^3	4.90×10^2mg/m^3
	Sample 2# in exhaust gas	CH_4	5.29×10^2mg/m^3	
	Sample 3# in exhaust gas	CH_4	3.08×10^2mg/m^3	
	Sample 4# in exhaust gas	CH_4	7.71×10^2mg/m^3	

	Sample 1# in exhaust gas	O_2	16.8%（v/v）	16.7%（v/v）
	Sample 2# in exhaust gas	O_2	16.7%（v/v）	
	Sample 3# in exhaust gas	O_2	16.8%（v/v）	
	Sample 4# in exhaust gas	O_2	9.3%（v/v）	
	Sample 1# in exhaust gas	H_2O	9.1%（v/v）	9.1%（v/v）
	Sample 2# in exhaust gas	H_2O	8.9%（v/v）	
	Sample 3# in exhaust gas	H_2O	9.1%（v/v）	
	Sample 4# in exhaust gas	H_2O	9.3%（v/v）	
	Sample 1# in exhaust gas	temperature	471°C	476°C
	Sample 2# in exhaust gas	temperature	475°C	
	Sample 3# in exhaust gas	temperature	481°C	
	Sample 4# in exhaust gas	temperature	475°C	
	Sample 1# in exhaust gas	pressure	0.098Kpa	0.100Kpa
	Sample 2# in exhaust gas	pressure	0.098Kpa	
	Sample 3# in exhaust gas	pressure	0.100Kpa	
	Sample 4# in exhaust gas	pressure	0.105Kpa	
700 °C	Sample 1# in residual gas	CH_4	4.51×10^5mg/m³	4.48×10^5mg/m³
	Sample 2# in residual gas	CH_4	4.29×10^5mg/m³	
	Sample 3# in residual gas	CH_4	4.65×10^5mg/m³	
	Sample 1# in residual gas	O_2	0.11%（v/v）	0.13%（v/v）
	Sample 2# in residual gas	O_2	0.14%（v/v）	
	Sample 3# in residual gas	O_2	0.13%（v/v）	
	Sample 1# in residual gas	H_2O	4.2%（v/v）	4.4%（v/v）
	Sample 2# in residual gas	H_2O	4.3%（v/v）	
	Sample 3# in residual gas	H_2O	4.0%（v/v）	
	Sample 1# in residual gas	temperature	46.3°C	47.4°C
	Sample 2# in residual gas	temperature	47.8°C	
	Sample 3# in residual gas	temperature	48.2°C	
	Sample 1# in residual gas	pressure	10.45Kpa	10.48Kpa
	Sample 2# in residual gas	pressure	10.47Kpa	
	Sample 3# in residual gas	pressure	10.51Kpa	
	Sample 1# in residual gas	flow	500m³/h	500m³/h
	Sample 2# in residual gas	flow	500m³/h	
	Sample 3# in residual gas	flow	500m³/h	
	Sample 1# in exhaust gas	CH_4	1.30×10^2mg/m³	92.15mg/m³
	Sample 2# in exhaust gas	CH_4	69.33mg/m³	
	Sample 3# in exhaust gas	CH_4	73.84mg/m³	
	Sample 4# in exhaust gas	CH_4	95.24mg/m³	
	Sample 1# in exhaust gas	O_2	14.1%（v/v）	13.9%（v/v）
	Sample 2# in exhaust gas	O_2	13.9%（v/v）	
	Sample 3# in exhaust gas	O_2	13.8%（v/v）	
	Sample 4# in exhaust gas	O_2	13.7%（v/v）	

	Sample 1# in exhaust gas	H_2O	10.1%（v/v）	10.3%（v/v）
	Sample 2# in exhaust gas	H_2O	9.8%（v/v）	
	Sample 3# in exhaust gas	H_2O	10.5%（v/v）	
	Sample 4# in exhaust gas	H_2O	10.7%（v/v）	
	Sample 1# in exhaust gas	temperature	681°C	684°C
	Sample 2# in exhaust gas	temperature	684°C	
	Sample 3# in exhaust gas	temperature	685°C	
	Sample 4# in exhaust gas	temperature	684°C	
	Sample 1# in exhaust gas	pressure	0.071Kpa	0.072Kpa
	Sample 2# in exhaust gas	pressure	0.073Kpa	
	Sample 3# in exhaust gas	pressure	0.071Kpa	
	Sample 4# in exhaust gas	pressure	0.073Kpa	
800 °C	Sample 1# in residual gas	CH_4	4.48×10^5mg/m^3	4.76×10^5mg/m^3
	Sample 2# in residual gas	CH_4	4.72×10^5mg/m^3	
	Sample 3# in residual gas	CH_4	5.07×10^5mg/m^3	
	Sample 1# in residual gas	O_2	0.18%（v/v）	0.16%（v/v）
	Sample 2# in residual gas	O_2	0.13%（v/v）	
	Sample 3# in residual gas	O_2	0.17%（v/v）	
	Sample 1# in residual gas	H_2O	5.2%（v/v）	5.4%（v/v）
	Sample 2# in residual gas	H_2O	5.3%（v/v）	
	Sample 3# in residual gas	H_2O	5.6%（v/v）	
	Sample 1# in residual gas	temperature	47.3°C	47.3°C
	Sample 2# in residual gas	temperature	46.7°C	
	Sample 3# in residual gas	temperature	47.8°C	
	Sample 1# in residual gas	pressure	10.49Kpa	10.49Kpa
	Sample 2# in residual gas	pressure	10.48Kpa	
	Sample 3# in residual gas	pressure	10.51Kpa	
	Sample 1# in residual gas	flow	500m^3/h	500m^3/h
	Sample 2# in residual gas	flow	500m^3/h	
	Sample 3# in residual gas	flow	500m^3/h	
	Sample 1# in exhaust gas	CH_4	56.79mg/m^3	38.16mg/m^3
	Sample 2# in exhaust gas	CH_4	28.95mg/m^3	
	Sample 3# in exhaust gas	CH_4	49.71mg/m^3	
	Sample 4# in exhaust gas	CH_4	17.19mg/m^3	
	Sample 1# in exhaust gas	O_2	11.5%（v/v）	10.8%（v/v）
	Sample 2# in exhaust gas	O_2	11.4%（v/v）	
	Sample 3# in exhaust gas	O_2	10.0%（v/v）	
	Sample 4# in exhaust gas	O_2	10.1%（v/v）	
	Sample 1# in exhaust gas	H_2O	8.3%（v/v）	7.9%（v/v）
	Sample 2# in exhaust gas	H_2O	8.2%（v/v）	
	Sample 3# in exhaust gas	H_2O	7.5%（v/v）	
	Sample 4# in exhaust gas	H_2O	7.5%（v/v）	

	Sample 1# in exhaust gas	temperature	754°C	754°C
	Sample 2# in exhaust gas	temperature	756°C	
	Sample 3# in exhaust gas	temperature	754°C	
	Sample 4# in exhaust gas	temperature	754°C	
	Sample 1# in exhaust gas	pressure	0.069Kpa	0.066Kpa
	Sample 2# in exhaust gas	pressure	0.067Kpa	
	Sample 3# in exhaust gas	pressure	0.065Kpa	
	Sample 4# in exhaust gas	pressure	0.065Kpa	

Second Test for Efficiency of Flare 2# in January 2009

Operation Temperature	Points	Variable	Value	Average
500°C	Sample 1# in residual gas	CH_4	408879mg/m^3	415864mg/m^3
	Sample 2# in residual gas	CH_4	416008mg/m^3	
	Sample 3# in residual gas	CH_4	422706mg/m^3	
	Sample 1# in residual gas	O_2	0.40%（v/v）	0.41%（v/v）
	Sample 2# in residual gas	O_2	0.43%（v/v）	
	Sample 3# in residual gas	O_2	0.41%（v/v）	
	Sample 1# in residual gas	H_2O	3.7%（v/v）	3.8%（v/v）
	Sample 2# in residual gas	H_2O	3.9%（v/v）	
	Sample 3# in residual gas	H_2O	3.9%（v/v）	
	Sample 1# in residual gas	temperature	34.6°C	34.5°C
	Sample 2# in residual gas	temperature	34.5°C	
	Sample 3# in residual gas	temperature	34.4°C	
	Sample 1# in residual gas	pressure	2.85Kpa	3.04Kpa
	Sample 2# in residual gas	pressure	3.18Kpa	
	Sample 3# in residual gas	pressure	3.10Kpa	
	Sample 1# in residual gas	flow	420m^3/h	422m^3/h
	Sample 2# in residual gas	flow	415m^3/h	
	Sample 3# in residual gas	flow	430m^3/h	
	Sample 1# in exhaust gas	CH_4	5.62mg/m^3	5.73mg/m^3
	Sample 2# in exhaust gas	CH_4	10.87mg/m^3	
	Sample 3# in exhaust gas	CH_4	2.23mg/m^3	
	Sample 4# in exhaust gas	CH_4	4.21mg/m^3	
	Sample 1# in exhaust gas	O_2	17.0%（v/v）	16.9%（v/v）
	Sample 2# in exhaust gas	O_2	16.9%（v/v）	
	Sample 3# in exhaust gas	O_2	16.8%（v/v）	
	Sample 4# in exhaust gas	O_2	16.8%（v/v）	
	Sample 1# in exhaust gas	H_2O	6.2%（v/v）	6.0%（v/v）
	Sample 2# in exhaust gas	H_2O	6.1%（v/v）	
	Sample 3# in exhaust gas	H_2O	5.8%（v/v）	
	Sample 4# in exhaust gas	H_2O	5.8%（v/v）	

	Sample 1# in exhaust gas	temperature	496°C	500°C
	Sample 2# in exhaust gas	temperature	497°C	
	Sample 3# in exhaust gas	temperature	504°C	
	Sample 4# in exhaust gas	temperature	502°C	
	Sample 1# in exhaust gas	pressure	0.125Kpa	0.135Kpa
	Sample 2# in exhaust gas	pressure	0.130Kpa	
	Sample 3# in exhaust gas	pressure	0.141Kpa	
	Sample 4# in exhaust gas	pressure	0.143Kpa	
700 °C	Sample 1# in residual gas	CH_4	410264mg/m^3	417757mg/m^3
	Sample 2# in residual gas	CH_4	422152mg/m^3	
	Sample 3# in residual gas	CH_4	420856mg/m^3	
	Sample 1# in residual gas	O_2	0.54%（v/v）	0.56%（v/v）
	Sample 2# in residual gas	O_2	0.57%（v/v）	
	Sample 3# in residual gas	O_2	0.56%（v/v）	
	Sample 1# in residual gas	H_2O	3.4%（v/v）	3.7%（v/v）
	Sample 2# in residual gas	H_2O	3.5%（v/v）	
	Sample 3# in residual gas	H_2O	4.2%（v/v）	
	Sample 1# in residual gas	temperature	35.0°C	35.0°C
	Sample 2# in residual gas	temperature	35.0°C	
	Sample 3# in residual gas	temperature	35.0°C	
	Sample 1# in residual gas	pressure	4.38Kpa	4.48Kpa
	Sample 2# in residual gas	pressure	4.50Kpa	
	Sample 3# in residual gas	pressure	4.56Kpa	
	Sample 1# in residual gas	flow	595m^3/h	582m^3/h
	Sample 2# in residual gas	flow	572m^3/h	
	Sample 3# in residual gas	flow	578m^3/h	
	Sample 1# in exhaust gas	CH_4	36.59mg/m^3	27.25mg/m^3
	Sample 2# in exhaust gas	CH_4	35.56mg/m^3	
	Sample 3# in exhaust gas	CH_4	2.41mg/m^3	
	Sample 4# in exhaust gas	CH_4	34.43mg/m^3	
	Sample 1# in exhaust gas	O_2	15.0%（v/v）	15.0%（v/v）
	Sample 2# in exhaust gas	O_2	15.1%（v/v）	
	Sample 3# in exhaust gas	O_2	15.0%（v/v）	
	Sample 4# in exhaust gas	O_2	14.9%（v/v）	
	Sample 1# in exhaust gas	H_2O	6.1%（v/v）	6.2%（v/v）
	Sample 2# in exhaust gas	H_2O	6.4%（v/v）	
	Sample 3# in exhaust gas	H_2O	6.0%（v/v）	
	Sample 4# in exhaust gas	H_2O	6.2%（v/v）	
	Sample 1# in exhaust gas	temperature	693°C	697.5°C
	Sample 2# in exhaust gas	temperature	698°C	
	Sample 3# in exhaust gas	temperature	698°C	
	Sample 4# in exhaust gas	temperature	701°C	

	Sample 1# in exhaust gas	pressure	0.121Kpa	0.123Kpa
	Sample 2# in exhaust gas	pressure	0.119Kpa	
	Sample 3# in exhaust gas	pressure	0.125Kpa	
	Sample 4# in exhaust gas	pressure	0.128Kpa	
800 °C	Sample 1# in residual gas	CH_4	400798mg/m^3	414054mg/m^3
	Sample 2# in residual gas	CH_4	414153mg/m^3	
	Sample 3# in residual gas	CH_4	427213mg/m^3	
	Sample 1# in residual gas	O_2	0.67%（v/v）	0.65%（v/v）
	Sample 2# in residual gas	O_2	0.66%（v/v）	
	Sample 3# in residual gas	O_2	0.62%（v/v）	
	Sample 1# in residual gas	H_2O	3.3%（v/v）	3.2%（v/v）
	Sample 2# in residual gas	H_2O	3.3%（v/v）	
	Sample 3# in residual gas	H_2O	3.1%（v/v）	
	Sample 1# in residual gas	temperature	33.0°C	32°C
	Sample 2# in residual gas	temperature	33.0°C	
	Sample 3# in residual gas	temperature	30.0°C	
	Sample 1# in residual gas	pressure	4.62Kpa	4.56Kpa
	Sample 2# in residual gas	pressure	4.46Kpa	
	Sample 3# in residual gas	pressure	4.60Kpa	
	Sample 1# in residual gas	flow	710m^3/h	702m^3/h
	Sample 2# in residual gas	flow	696m^3/h	
	Sample 3# in residual gas	flow	699m^3/h	
	Sample 1# in exhaust gas	CH_4	11.09mg/m^3	14.43mg/m^3
	Sample 2# in exhaust gas	CH_4	20.44mg/m^3	
	Sample 3# in exhaust gas	CH_4	1.04mg/m^3	
	Sample 4# in exhaust gas	CH_4	12.57mg/m^3	
	Sample 1# in exhaust gas	O_2	14.5%（v/v）	13.9%（v/v）
	Sample 2# in exhaust gas	O_2	13.8%（v/v）	
	Sample 3# in exhaust gas	O_2	13.8%（v/v）	
	Sample 4# in exhaust gas	O_2	13.5%（v/v）	
	Sample 1# in exhaust gas	H_2O	5.3%（v/v）	5.2%（v/v）
	Sample 2# in exhaust gas	H_2O	5.0%（v/v）	
	Sample 3# in exhaust gas	H_2O	5.3%（v/v）	
	Sample 4# in exhaust gas	H_2O	5.3%（v/v）	
	Sample 1# in exhaust gas	temperature	760°C	768°C
	Sample 2# in exhaust gas	temperature	765°C	
	Sample 3# in exhaust gas	temperature	773°C	
	Sample 4# in exhaust gas	temperature	775°C	
	Sample 1# in exhaust gas	pressure	0.101Kpa	0.101Kpa
	Sample 2# in exhaust gas	pressure	0.102Kpa	
	Sample 3# in exhaust gas	pressure	0.099Kpa	
	Sample 4# in exhaust gas	pressure	0.103Kpa	

ATTACHMENTS

1. Data sheets for monthly monitoring data of Xiaping LFG Project (0:00 01/02/2009 -24:00 30/09/2009).
2. Test sheets for flare (flare 1# and flare 2#) combustion efficiency.
3. Calibration certificates for flow meters, methane fraction meter and electricity meter by Government Authorized Metering Monitoring Organization.

AVAILABLE DOCUMENTS FOR REFERENCE OF DOE VERIFICATION ON SITE：

1. Worksheet of daily operation data of Xiaping LFG Project.
2. Xiaping LFG Project CDM Management Manual.
3. Product Qualified Certificates of Flow Meter, Methane Fraction Analyzers and electricity meter issued by the Manufacturer.
4. Invoices issued to the local grid for LFG electricity generation and Invoices with Xiaping landfill for project consumption.
5. Documents included in the mentioned attachments.