VCS 2007.1 Monitoring Report

Fuzhou Hongmiaoling Landfill Gas to Electricity Project

Monitoring period:

19/11/2007 – 16/11/2008

Version 3.0

November 20th, 2009

Climate Bridge Ltd.

1. Introduction

The purpose of this report is to calculate the emission reductions generated by Fuzhou Hongmiaoling Landfill Gas to Electricity Project (hereafter refers to the proposed project, the reference number is 1732) located in Fuzhou City, Fujian Provinces, P.R. China during the crediting and monitoring period covered by this report, and to serve as basis for the verification and issuance of corresponding VCUs.

1.1 Monitoring Period

From 19/11/2007 to 16/11/2008

1.2 Document Reference

Version: 3.0
Date: November 20th 2009

2. General Description of the Project

2.1 Summary

The proposed project is a landfill gas (LFG) collection and utilization project in Fuzhou City, which involves the installation of a gas collection system, leachate drainage system, flaring equipment and an electricity generation plant at Fuzhou Hongmiaoling Landfill. The generators will combust methane in the landfill gas to produce electricity and export to regional grid. The project was planned to install three GE gas engineers with a total capacity of 2.5MW. But only two GE gas engines, each with 825kW, were installed with a total capacity of 1.65MW currently. The electricity generated is sold to Fujian Provincial Power Grid that is part of East China Power Grid to replace certain capacity of coal-fired power plants. Excess landfill gas, and all the gas collected during the period when electricity is not produced will be flared. The proposed project is registered as a CDM project on November 17th 2008.

During the monitoring period, the plant operated normally. Some short shut downs are recorded in the operation log. The total operation time of the plant is 7895h during the monitoring period[1].

Please refer to the project PDD[2] for more detailed information.

2.2 Technical Description of the Project Activity

The proposed project is located at bottom of Lianhua Mountain, Hongmiaoling, and 17 km northwest of Fuzhou City, Fujian Province, P. R. China. Its geographical coordinates are north

[1] 16 days in total of whole day shut downs for maintenance during the monitoring period. Other short shut downs are also recorded in the operation log.
[2] http://cdm.unfccc.int/Projects/DB/DNV-CUK1204757435.62/view

latitude of 26°05′ and east longitude of 119°18′.The location is showed in Figure 2-1.

Figure 2-1 Location of the proposed project

The gas engines employed by the project are GE engines (model: JGS 316 GS-L.L). Key technical indicators are listed in the Table 2-1.

Table 2-1 Technical indicators of the gas engines

GE model: JGS 316 GS-L.L	
Electric power output	825kW
Electricity efficiency	39.8%
Total efficiency	39.8%
Methane number (Mz)	100
Calorific value (Hu)	4 kWh/Nm^3
Fuel gas volume	524 ± 5% Nm^3/h

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3. Monitoring Methodology and Plan

3.1 Monitoring Methodology

The project activity uses the approved consolidated baseline and monitoring methodology ACM0001: "Consolidated methodology for landfill gas project activities" (Version 05) and the Approved Methodology: AMS-I.D. "Grid connected renewable electricity generation" (Version 11).

Tool to determine project emission from flaring gases containing methane to calculate the project emissions (Version 1).

For more information regarding the methodology, please refer to UNFCCC's website: http://cdm.unfccc.int/methodologies/PAmethodologies/approved.html.

3.2 Monitoring Data and Parameters

The following parameters are required to be monitored during the proposed crediting period in accordance with the project monitoring plan described in the project PDD.

Data / Parameter:	$LFG_{total, y}$
Data unit:	m^3
Description:	Total amount of LFG captured
Source of data to be used:	On-site monitored
Value during the monitoring period	5502221.5
Description of measurement methods and procedures to be applied:	Data will be measured continuously with a flow meter by the project developer. The flow meter will be maintained and calibrated regularly in line with the manufacturer's requirements. This will ensure that the accuracy of the measurement instrument is maintained. Data to be aggregated monthly and yearly.
QA/QC procedures to be applied:	Flow meter will be subject to a regular maintenance and testing regime to ensure accuracy. The meter is calibrated annually. The accuracy of the meter is 1.5s.

Data / Parameter:	$LFG_{electricity, y}$
Data unit:	m^3
Description:	Total amount of LFG for power generation
Source of data to be used:	On-site monitored
Value during the monitoring period	5349425.3
Description of measurement methods and procedures to be applied:	Data will be measured continuously with a flow meter by the project developer. The flow meter will be maintained and calibrated regularly in line with the manufacturer's requirements. This will ensure that the accuracy of the measurement instrument is maintained. Data to be aggregated monthly and yearly.
QA/QC procedures to be applied:	Flow meter will be subject to a regular maintenance and testing regime to ensure accuracy. The meter is calibrated annually. The accuracy of the meter is 1.5s.

Data / Parameter:	$LFG_{flare, y}$
Data unit:	m^3
Description:	Total amount of LFG for flaring

Source of data to be used:	On-site monitored
Value during the monitoring period	152795.8
Description of measurement methods and procedures to be applied:	Data will be measured continuously with a flow meter by the project developer. The flow meter will be maintained and calibrated regularly in line with the manufacturer's requirements. This will ensure that the accuracy of the measurement instrument is maintained. Data to be aggregated monthly and yearly.
QA/QC procedures to be applied:	Flow meter will be subject to a regular maintenance and testing regime to ensure accuracy. The meter is calibrated annually. The accuracy of the meter is 1.5s.

Data / Parameter:	$EG_{EX, LFG}$
Data unit:	MWh
Description:	Total amount of electricity exported out of the project
Source of data to be used:	On-site monitored
Value during the monitoring period	8227.2
Description of measurement methods and procedures to be applied:	Required to monitor the emission reductions from electricity generation from LFG, and to cross-check the measurement against the sales receipts. Electricity will be measured continuously using an electricity meter that will be maintained and calibrated regularly to assure high levels of accuracy. The accuracy of the meter is 0.5s. The meter is calibrated every 5 years.
QA/QC procedures to be applied:	Electricity meter will be maintained and calibrated regularly to ensure that the accuracy of the measurement instrument is maintained

Data / Parameter:	EL_{IMP}
Data unit:	MWh
Description:	Total amount of electricity imported to meet project requirements.
Source of data to be used:	On-site monitored
Value during the monitoring period	23.8

Description of measurement methods and procedures to be applied:	Required to determine CO_2 emissions from use of electricity or other energy carriers to operate the project activity. The records of any electricity imported in the baseline also should be recorded at the start of project. The precision of the meter is 0.5s. The meter is calibrated every 5 years.
QA/QC procedures to be applied:	Measurements are to be cross-checked with sales receipts. Electricity meter is to be maintained and calibrated regularly to ensure that the accuracy of the measurement instrument is maintained.

Data / Parameter:	W_{CH4}
Data unit:	m^3 CH_4/m^3 LFG
Description:	Methane fraction in the LFG
Source of data to be used:	On-site monitored
Description of measurement methods and procedures to be applied:	Methane content will be measured continuously with a fixed gas analyzer by the project developer. The gas analyzer will be maintained and calibrated regularly in line with the manufacturer's requirements in order to ensure that factory standards of accuracy are maintained.
QA/QC procedures to be applied:	The gas analyzer should be subject to a regular maintenance and testing regime to ensure accuracy the gas analyzer is calibrated yearly. The max linearity error of the gas analyzer is 4.0%.

Data / Parameter:	T_{flare}
Data unit:	℃
Description:	Temperature in the exhaust gas of the flare
Source of data to be used:	Continuous measured
Description of measurement methods and procedures to be applied:	Measure the temperature of the exhaust gas stream in the flare by a Type N thermocouple. A temperature above 500℃ indicates that significant amount of gas are still being burnt and that the flares are operation.
QA/QC procedures to be applied:	Thermocouples should be replaced or calibrated every year.

Data / Parameter:	T_t

Data unit:	℃
Description:	Temperature of landfill gas.
Source of data to be used:	Continuous measured
Description of measurement methods and procedures to be applied:	Measure the temperature of landfill gas. Three thermometers are installed to monitor the temperature of total landfill gas, landfill gas to electricity generators and landfill gas to flare system
QA/QC procedures to be applied:	Thermometers are calibrated annually. The uncertainty of the thermometers is 0.1 ^{o}C.

Data / Parameter:	P
Data unit:	Pa
Description:	The pressure of landfill gas
Source of data to be used:	Project developer
Description of measurement methods and procedures to be applied:	Pressure of the landfill gas is measured by pressure meter and recorded monthly. Three manometers are installed to measure the pressure of total landfill gas, landfill gas to electricity and landfill gas to flare system
QA/QC procedures to be applied:	Meter shall be operated and maintained as per the specifications prescribed by the manufacturer. The meter is calibrated annually. The uncertainty of the meter is 0.05%.

Data / Parameter:	$MD_{electricity}$
Data unit:	tCH_4
Description:	Methane destroyed in power plant
Source of data to be used:	Calculated by computer system
Description of measurement methods and procedures to be applied:	Calculated base on the parameters above $MD_{electricity} = LFG_{electricity, y} * W_{CH4} * D_{CH4}$
QA/QC procedures to be applied:	

Data / Parameter:	MD_{flare}
Data unit:	tCH_4
Description:	Methane destroyed in flaring
Source of data to be used:	Calculated by computer system

Description of measurement methods and procedures to be applied:	Calculation should follow the formula described in Section 4.2.
QA/QC procedures to be applied:	

Data / Parameter:	Operation hours of flare
Data unit:	Hour
Description:	Operation hours of the flare
Value during the monitoring period:	656
Source of data to be used:	Recorded by computer system
Description of measurement methods and procedures to be applied:	
QA/QC procedures to be applied:	Equipment is operated and maintained in line with manufacturer's recommendations to ensure high quality output.

Data / Parameter:	Operation hours of the power plant
Data unit:	Hour
Description:	Operation hours of the power generation plant
Value during the monitoring period:	7895
Source of data to be used:	Recorded by computer system
Description of measurement methods and procedures to be applied:	
QA/QC procedures to be applied:	Equipment is operated and maintained in line with manufacturer's recommendations to ensure high quality output.

3.3 Monitoring Plan

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

The monitoring team is organized followed the structure description in the PDD. The general manager is responsible for the operation for the project. CDM manager is responsible for the on-site operation. Finical chief keeps all invoices related to the project. Technical chief is responsible for the technical part of the operation. And plant operation manager is responsible for the daily operation and data recording.

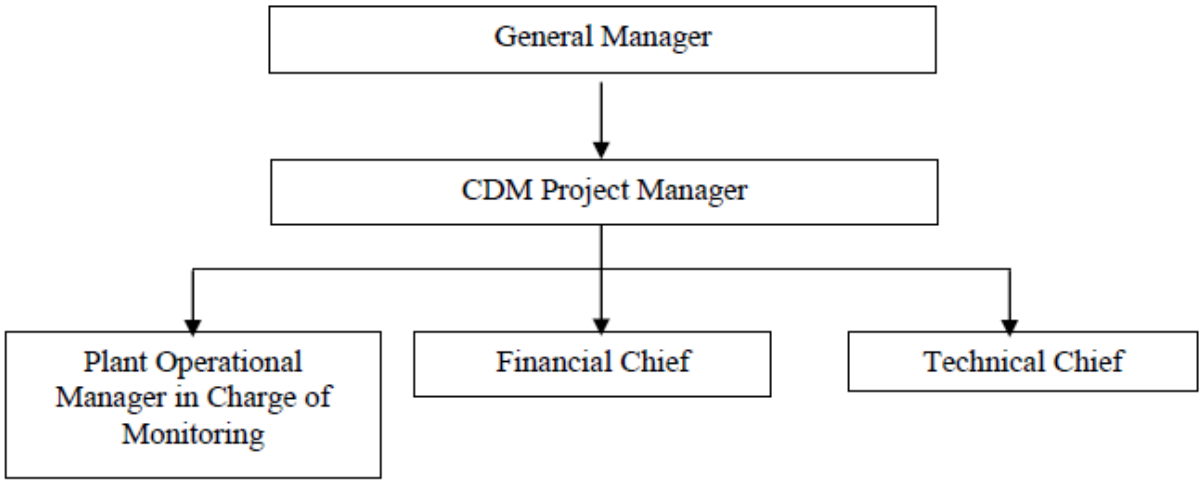

Figure 3-1 organization structure of monitoring team

To ensure accuracy, an agreement on measurement arrangement and quality control process was signed between the project developer and the electricity grid company. Equipment of measurement is to be yearly checked and calibrated to ensure accuracy. The project owner prepared backup procedures to deal with any errors occurred to the meters.

The electricity grid company verified the electricity quantity and provided the records to the developer. The records were preserved by the developer and the third party nominated.

The metering equipments used for monitoring LFG such as flow meter, online catharometer and temperature pickup were calibrated and checked for accuracy, the frequency of which strictly followed the National Calibration Standard.

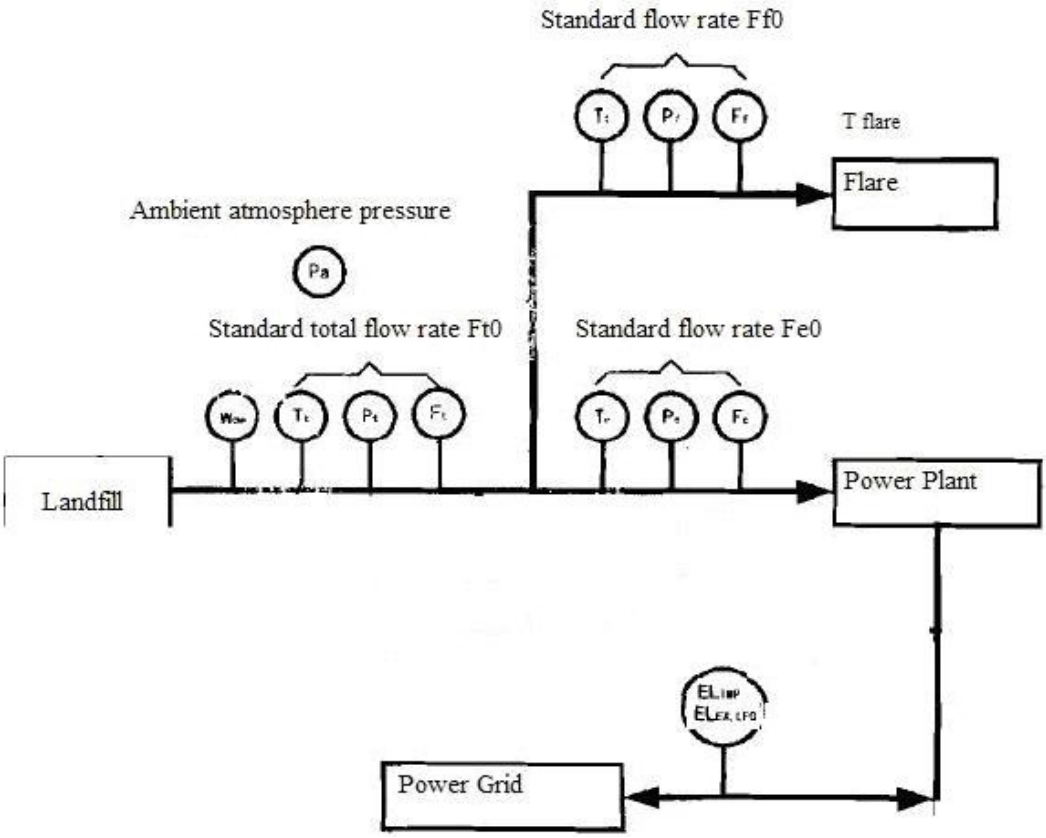

Figure 3-2 Equipment Flow Chart

Measurements:

$W_{CH\,4}$ = Volume fraction of CH_4

Pa = Ambient atmosphere pressure

Tt = Temperature

Pt = Pressure

Ft = Actual flow rate of LFG (m^3)

Ft0, Fe0, Ff0 = Standard flow rate (calculated using parameters Tt, Pt and Ft)

3.4 QA/QC Procedure

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

1) The on-site monitoring staff is divided into 3 teams and wok on three shifts in 24 hours taking charging of plant operation management and data collection.

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

3) Operation of the equipments in the project is supported by technical experts from equipments providers to ensure that all equipments are in good conditions.

4) Project owner sends related equipments to do calibrations according to the national standards and keeps copies of all the calibration reports. And project owner prepares backup procedures to deal with any errors occurred to the meters. The electricity quantity during the period will be decided according to the error disposal procedure.

4. GHG Calculations

4.1 Project Emissions and Leakages

As no other fuels are used within the project boundary, the project emission (PE_y) is zero according to the referred methodology. And no leakage (L_y) effects need to be accounted under this methodology.

Thus, no project emission is considered, therefore, $PE_y = 0$, $L_y=0$.

4.2 Emission Reductions

According to ACM0001, the emission reductions will be calculated as follows:

$$ER_y = (MD_{project,y} - MD_{reg,y}) * GWP_{CH4} + EG_y * CEF_{electricity} - ET_y * CEF_{thermal,y} \quad (1)$$

With:

ER_y: greenhouse gas emission reduction achieved by the project activity during a given year "y" (t CO_2e).

$MD_{project,y}$: amount of methane actually destroyed/combusted during the year "y" (tCH_4).

$MD_{reg,y}$: amount of methane that would have been destroyed/combusted during the year "y" in the absence of the project activity (tCH_4). The value for the project is 0 according to the project PDD during the first commitment period.

GWP_{CH4}: approved Global Warming Potential value for methane (21 t CO_2e / tCH_4).

EG_y: net quantity of electricity displaced during the year "y" (MWh).

$CEF_{electricity,y}$: CO_2 emissions intensity of the electricity displaced during year "y" (tCO_2e/MWh). the emission factor is calculated in the registered PDD. According to the calculation, the value is 0.8541tCO_2e/MWh.

ET_y: incremental quantity of fossil fuel, defined as difference of fossil fuel used in the baseline and fossil fuel used during the project, for energy requirement on site under project activity during the year y, in TJ.

$CEF_{thermal,y}$: CO_2 emissions intensity of the thermal energy displaced during year "y" (tCO_2e/TJ).

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

With:

$MD_{flared,y}$ amount of methane destruction in flares during the year y;

$MD_{electricity,y}$ amount of methane destruction in power plant during the year y;

$MD_{thermal,y}$ amount of methane destruction in heating during the year y; There is no heating

activity in the proposed project, $MD_{thermal, y}=0$.

$$MD_{electricity, y} = LFG_{electricity, y} * w_{CH4,y} * D_{CH4} \quad (3)$$

With:
$LFG_{electricity, y}$ amount of landfill gas destruction in power plant.
$w_{CH4,y}$ is the average methane fraction of the landfill gas as measured during the year and expressed as a fraction (m^3CH_4/m^3 LFG)
D_{CH4} methane density (0.0007168 tCH_4/m^3CH_4)

In the proposed project, the $MD_{electricity, y}$ calculated automatically by computer system was base on equation (3).

$$MD_{flare, y} = (LFG_{flare, y} * w_{CH4,y} * D_{CH4}) - (PE_{flare, y}/GWP_{CH4}) \quad (4)$$

With:
$LFG_{flare, y}$ amount of landfill gas fed to the flare during the yea measured in cubic meters (m^3)
$PE_{flare, y}$ the project emissions from flaring of the residual gas stream in year y (tCO_2e). The value should be calculated followed the procedure described in the "Tool to determine project emission from flaring gases containing Methane". For detailed calculation please refer to Section 4.3.

In the proposed project, the $MD_{flare, y}$ calculated automatically by computer system was base on equation (5).

$$EG_y = EL_{EX, LFG} - EL_{IMP} \quad (5)$$

With:
$EL_{EX, LFG}$ total amount of electricity exported out of the project boundary (MWh)
EL_{IMP} total amount of electricity imported to meet project requirement (MWh)

Therefore, the emission reductions for the project during the proposed crediting period can be calculated using the following formula:

$$ER_y = MD_{project, y} * GWP_{CH4} + EG_y * CEF_{electricity} - ET_y * CEF_{thermal, y} \quad (6)$$

For detailed calculation please refer to section 4.3

4.3 Data and Emission Reductions Calculation
Detailed monitoring data is shown in the table 4-1 below.

Table 4-1 The monitoring data from November 19th 2007 to November 16th 2008

Period		LFG captured ($LFG_{total, y}$)	LFG for power generation ($LFG_{electricity, y}$)	LFG for flaring ($LFG_{flare, y}$)	methane destruction in power plant ($MD_{electricity, y}$)	Invoice record ($EG_{EX,LFG}$)	Electricity imported from the grid (EL_{IMP})
		m^3	m^3	m^3	tCH_4	MWh	MWh
2007	Nov 19th-30th	165060.95	152881.61	12179.34	65.06	584.922	5.400
	Dec	228987.39	204185.83	24801.57	96.34		5.790
2008	Jan	360951.72	313663	47288.72	138.81	515.380	5.730
	Feb	626599.94	625149.06	1450.78	253.53	950.309	0.030
	Mar	586677.75	579292.38	7385.49	212.73	814.116	0.840
	Apr	558993.75	553114.87	5878.95	203.34	954.929	0.006
	May	526170	491768.25	34403.15	193.43	792.803	0.870
	Jun	505752.25	499925.5	5826.56	182.58	726.123	0.570
	Jul	515513	514642.75	868.3	183.41	832.061	0.180
	Aug	483790.75	479322	4466.31	168.45	654.017	2.100
	Sep	368457	363085	5373.8	136.08	594.819	0.930
	Oct	411568	410495	1073	140.231	574.192	0.300
	Nov 1st- 16th	163699	161900	1799.8	56.762	233.496*	1.080
Total		**5502221.5**	**5349425.3**	**152795.8**	**2030.8**	**8227.2**	**23.8**

* Do not have invoice record for half month, the data was calculated based on on-site monitoring record: on-site record*(1- 0.64% (power loss rate))

Therefore, the emission reductions achieved by the project is calculated as follows:

The electricity data was recorded using meters with precision of 0.5s. But in the description of the registered PDD, the precision of meters should be 0.2s. For conservative, the error that may cause by the precision difference was reduced using equation below:

Modified electricity exported = $EL_{EX, LFG}$ *(1－0.5%)
Modified electricity imported = EL_{IMP} *(1+0.5%)

According to the formula (4) in Section 4.2, the MD_{flare} should be judged in hourly interval to ensure the flaring condition meet the requirements. As the flare system was not often used during the monitoring period the project only monitored the accumulated operation hour of flare system. Because the methane flared in the flare was not monitored properly according to the registered PDD, to be conservative, the value of $MD_{flare, y}$ was considered to be zero in the calculation.

2007.11.19-2007.12.31:
Modified electricity output = $EG_{EX, LFG}$ *(1-0.5%) = 584.922MWh * 0.995 = 581.997 MWh
Modified electricity imported = EL_{IMP} *(1+0.5%) = 11.190MWh *1.005= 11.245MWh

EG_y = 581.997MWh-11.245MWh=570.752MWh

$MD_{project, y} = MD_{electricity\ y} + MD_{flare, y}$ =161.400+0=161.4 tCH_4

ER $_y$= $MD_{project\ y} * GWP_{CH4} + EG_y * CEF_{electricity}$=161.4$tCH_4$*21+570.751MWh*0.8541 tCO2e/MWh=3877tCO_2e

2008.1.1-2008.11.16:
Modified electricity output = $EG_{EX, LFG}$ *(1-0.5%) = 7642.245MWh * 0.995 = 7604.033 MWh.
Modified electricity imported = EL_{IMP} *(1+0.5%) = 12.610MWh * 1.005= 12.673MWh

EG_y = 7604.033MWh-12.673MWh=7591.36MWh

$MD_{project, y} = MD_{electricity\ y} + MD_{flare, y}$ =1869.353+0=1869.353 tCH_4

During the monitoring period, LPG was used occasionally for the flaring system, and the emission from the LPG is calculated as follows:

ET y =the amount of the LPG used during the crediting period*NCV_{LPG}=15kg*50,179 kJ/kg=752,685kJ=0.000752685TJ

15kg of LPG was consumed during the crediting period for flaring system, and the caloric value of LPG is 50,179 kJ/kg (NCV_{LPG}) according to China Energy Yearbook 2008.

$ET_y * CEF_{thermal, y}$ =0.000752685TJ*65.6 tCO_2e/TJ=0.0494 tCO_2e

According to the Volume 2 Energy, 2006 IPCC Guidelines for National Greenhouse Gas Inventories, the CO2 emission intensity of the LPG adopts 65.6 tCO_2e/TJ (upper limit of 95% confidence interval).

$ER_y = MD_{project\ y} * GWP_{CH4} + EG_y * CEF_{electricity} - ET_y * CEF_{thermal, y}$
=1869.353tCH_4*21+7591.36MWh*0.8541 tCO2e/MWh −0.0494 tCO_2e
=45740 tCO_2e
39256.413
So the total emission reductions for the whole monitoring period
2007.11.19-2008.11.16
ER_y= 3,877 tCO_2e + 45,740 tCO_2e = 49,617 tCO_2e

The result of the calculation is summarized in below table:

Monitoring Period	**Emission reduction (tCO_2e)**
19/11/2007-31/12/2007	3,877
01/01/2008-16/11/2008	45,740
Total	
19/11/2007-16/11/2008	49,617