**MONITORING REPORT**
**Version 02 , Jan 19, 2012**

**Title project activity: Shenyang Laohuchong LFG Power Generation Project**
**Reference number: 1906**
**Second monitoring period: 01 April 2010 – 31 July 2011 (included)**

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## SECTION A. General description of the project activity

### A.1. Brief description of the project activity: >>

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 2,000Nm3/h. During this monitoring period, only three power generators with a capacity of 1.5MW 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 October 18, 2007 and the operation of the LFG power generation system started on March 4, 2008. The other three engines are scheduled to be installed as soon as the flow of the biogas will be high and stable enough to guarantee suitable working conditions.
   The leachate is treated by the landfill owner.
4. Total emission reductions achieved in this monitoring period is 107,353 ton $CO_2$eq.

### A.2. Project Participants

The participants involved in this project are listed in the following table:

| Name of Party Involved ((host) indicates an host Party) | Private and/or public entity(ies) project participants | Kindly indicate if the Party involved wishes to be considered as project participant |
|---|---|---|
| China (host) | Shenyang Laohuchong Municipal Solid Waste Management Co. Ltd. (Public Entity) | No |
| Italy | Asja Ambiente Italia S.p.A. (Private Entity) | No |
| Switzerland | ICF - International Clean Fund LLC Lewes, Mendrisio Branch (Private Entity) | No |

## A.3. Location of the project activity:

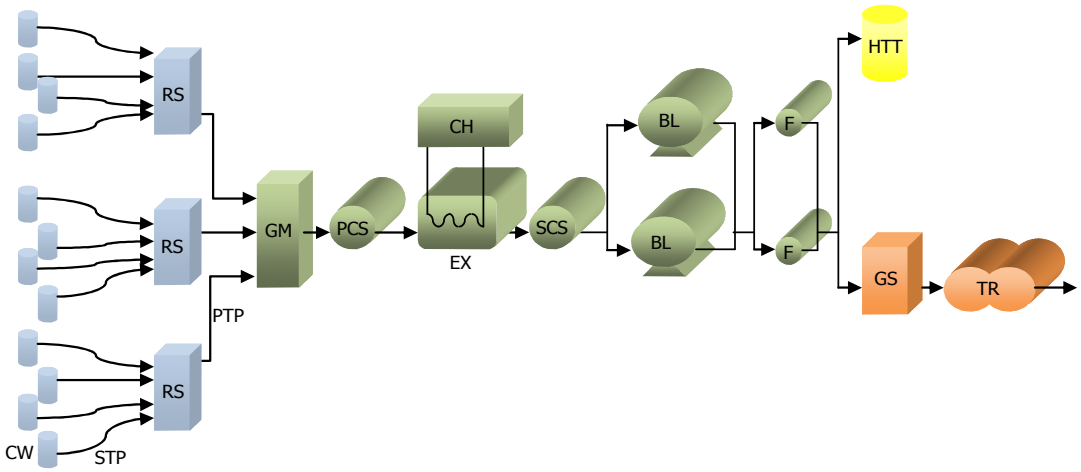
This project is located in Tashan Farm, Chenxiang Town, Su Jiatun District, Shenyang, Liaoning, People's Republic of China, with the GPS coordinates of 41°33' N and 123°34 E.

## A.4. Technical description of the project

The whole general layout includes landfill gas collecting, pre-treatment, power generation and flare combustion systems. The following sections are recognized:

1. biogas collection and conveying section
2. biogas suction, treatment and analysis section
3. enclosed high-temperature flare biogas combustion
4. electricity generation, transformation and distribution section

These sections are schematically showed in the pictures below:




| Collection Section | Suction and Control Section | Electricity generation and Torch Section |
|---|---|---|

| Collection Section | Suction and Control Section | Electricity generation and Torch Section |
|---|---|---|
| **CW**: Capture Well | **GM**: General Intake Manifold | **GS**: Generation Set |
| **STP**: Biogas Secondary Transport Pipelines | **PCS**: Primary Condensate Separator | **HTT**: High Temperature Torch |
| **RS:** Regulation Substation | **EX**: Pipe bundle Heat Exchanger | **TR**: Transformer |
| **PTP**: Biogas Primary Transport Pipelines | **SCS**: Secondary Condensate Separator | |
| | **CH**: Chiller | |
| | **F**: Dry filter | |
| | **BL**: Blower | |

## A.5. Title, reference and version of the baseline and monitoring methodology applied to the project activity:

Approved monitoring methodology and tools applied to this projects:

**ACM0001 - Version 6**: "Consolidated baseline methodology for landfill gas project activity"
**ACM0002 - Version 6**: "Consolidated baseline methodology for grid-connected electricity generation from renewable sources"

Tool for the demonstration and assessment of additionality - Version 4
Tool to determine project emissions from flaring gases containing methane

## A.6. Registration date of the project activity:

This project was registered on Dec.25, 2008.

**A.7. Crediting period of the project activity and related information (start date and choice of crediting period):**

The Crediting period of this project activity is 25 December 2008 - 24 December 2018 (Fixed).
The start date of the crediting period has been changed from Jan 1st, 09 into December 25, 2008 and it has been accepted by the Board

**A.8. Name of responsible person(s)/entity(ies)**

The monitoring report is completed in September 2011, 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 the project activity**

**B.1. Implementation status of the project activity**

The installation of two new generators (4# and 5#) manufactured in 05/2011 was finished on Sep 15th, 2011 as it can be seen in the installation declaration issued by the generator's manufacturer.

There were no events or situations occurred during the monitoring period, which impacted the applicability of the methodology.

**B.2. Revision of the monitoring plan**

None

**B.3. Request for deviation applied to this monitoring period**

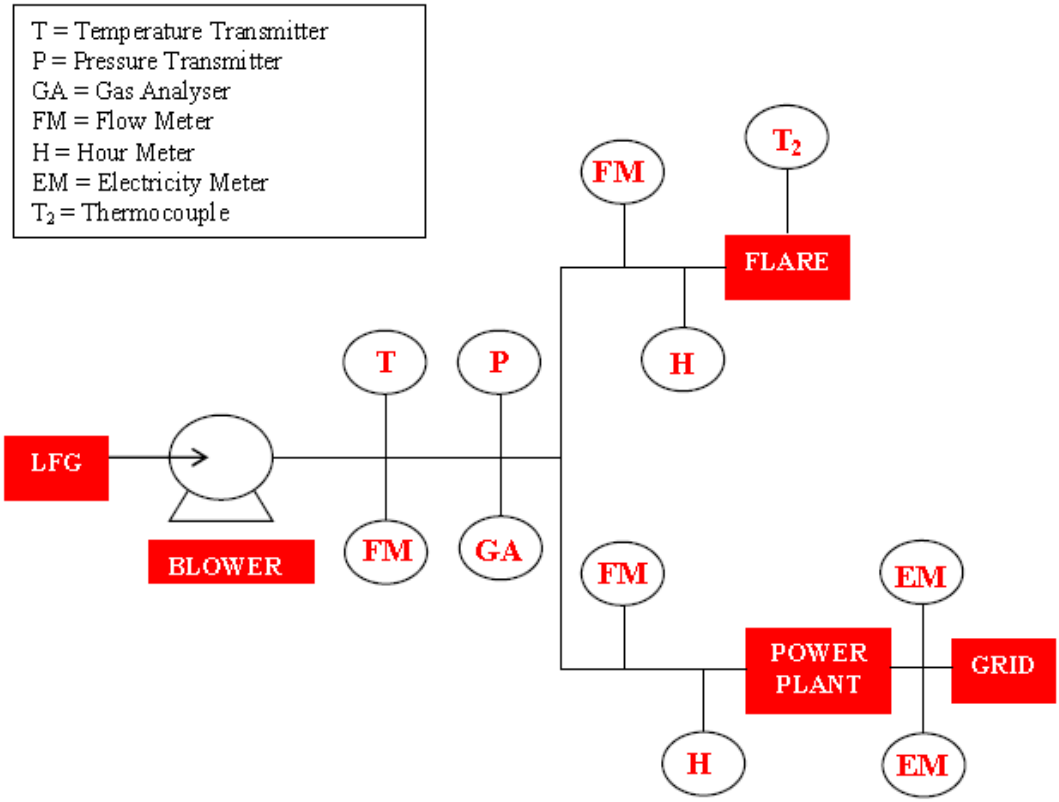
None

**B.4. Notification or request of approval of changes**

Not applicable

## SECTION C. Description of the monitoring system

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.).

## 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 three 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*".

**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

Moreover, FDS automatically puts the monitored data onto a spreadsheet (onto its first sheet, called "rawdata") created by Asja.biz for the calculation of the **Emissions Reduction due to methane destruction** and makes available all the needed reports with the daily and monthly amount of CERs. This spreadsheet for the MD calculation (also referred to as the "master") follows the formula as per the methodological "tool to determine project emissions from flaring gases containing methane" and it is available for the DOE. The monitored data and the calculated CERs are aggregated hourly, monthly and yearly in a standard format for reporting purposes (see the attached Monitoring sheet).

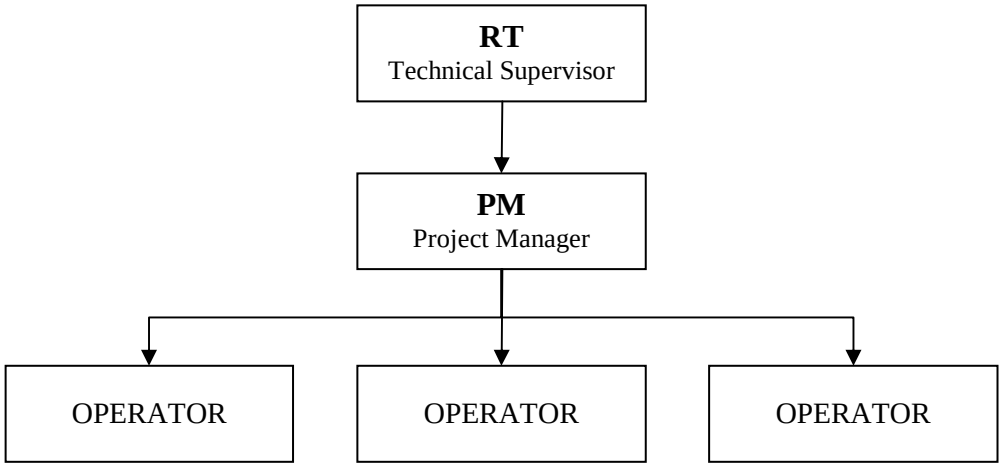
Instruments → PLC → FDS → MD Calculation Spreadsheet → Monitoring sheets

All these operations are completely automatic and safe, and a declaration of the FDS company is available.

All the FDS system and its data are continuously stored also in a back-up system in a portable hard-disk (mirroring).
Besides the FDS database, a document control system has been implemented to ensure that the monitored data and all the necessary documents (such as operation manual, drawings, maintenance and calibration instructions, etc.) are available and stored in a proper manner. Monitored data (rawdata) and Monitoring Sheets (monthly reports), both downloaded from FDS, are copied to magnetic media every month and stored in appropriate archives. All data, including calibration records and Monitoring Reports, will be kept until 2 years after the crediting period.

## 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:
- Wang Liwei
- Li Baobin
- Yao Gang
- Zhao Liang
- 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

## 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.

*Management of gas analyzer data not logged because of a calibration*
Every month an internal calibration of the fixed analyzer is carried out. When it is not possible to find a more suitable period, the calibration occurs during the plant working. In this case, the responsible disconnects the fixed analyzer from PLC to avoid that during the calibration the analyzer, still connected to PLC, makes FDS automatically calculate CERs, in case of the biogas analyzer, according to the methane content of sample gas (above 90%), and not according to the actual content of LFG (around 50%). Disconnecting the analyzer, the PLC (and therefore FDS) reads a value of zero for the methane content. In this way, the plant is still operating but CERs calculated in this calibration period are zero.

*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 determined at registration and not monitored during the monitoring period, including default values and factors

| **Data / Parameter:** | $GWP_{CH4}$ |
|---|---|
| Data unit: | $tCO_{2e}/tCH_4$ |
| Description: | Global Warming Potential value for methane |
| Source of data used: | Revised 1996 IPCC Guideline for National Greenhouse Gas Inventory |
| Value(s) | *21* |
| Indicate what the data are used for | Used for baseline emission calculation |
| Additional comments: | |

| **Data / Parameter:** | ρCH4,n,h |
|---|---|
| Data unit: | $tCH_4/m^3CH_4$ |
| Description: | Density of methane gas at normal conditions |
| Source of data used: | *Tool to determine project emissions from flaring gases containing methane* |
| Value(s) | *0.0007168* |
| Indicate what the data are used for | Used for baseline emission calculation |
| Additional comments: | |

| **Data / Parameter:** | CEFelec,y |
|---|---|
| Data unit: | tCO2/MWh |
| Description: | The emission factor of northeast electric power grid |
| Source of data used: | *Data published by China DNA on http://cdm.ccchina.gov.cn* |
| Value(s) | *1.05176* |
| Indicate what the data are used for | Used for both baseline and project emission calculations |
| Additional comments: | |

<table>
<tr><td>Data / Parameter:</td><td>Local and national regulatory framework</td></tr>
<tr><td>Data unit:</td><td></td></tr>
<tr><td>Description:</td><td>Law and regulations about waste management systems in China</td></tr>
<tr><td>Source of data used:</td><td>Data published by China DNA</td></tr>
<tr><td>Value(s)</td><td>
<table>
<tr><th>Regulation reference</th><th>Regulation</th><th>Impact</th><th>Date of application</th></tr>
<tr><td>GB16889-1997</td><td>“Standard for Pollution Control on the Landfill Site of Municipal Solid Waste”</td><td>Included in PDD</td><td>01-Jan-98</td></tr>
<tr><td>GB16889-2008</td><td>“Standard for Pollution Control on the Landfill Site of Municipal Solid Waste”</td><td>No impact on parameters monitored during the current crediting period. The methodology requires the impacts of new regulations to be considered at the renewal of the crediting period. The project has a fixed crediting period of 10 years and will not be renewed. Furthermore, the regulation is an E-type regulation according Annex 3 of EB 22.</td><td>01-Jul-08</td></tr>
</table>
</td></tr>
<tr><td>Indicate what the data are used for (Baseline/project/leakage emission calculations)</td><td>Used for baseline emission calculation</td></tr>
</table>

## D.2. Data and parameters monitored

| **Data / Parameter:** | $LFG_{total,y}$ |
|---|---|
| Data unit: | $Nm^3$ |
| Description: | Total amount of landfill gas captured |
| Measured / Calculated / Default | *Measured* |
| Source of data: | *Flow meter* |
| Value(s) of monitored parameter: | *12,858,228* |
| Indicate what the data are used for) | Used for baseline emission calculation. |
| Monitoring equipment (type, Accuracy class, serial number, calibration frequency, date of last calibration, validity) | Flow meter<br>Type: Annubar 485<br>Accuracy class: ±0.9%<br>Serial number: 01726699<br>calibration frequency: Every year<br>Date of calibrations: Sep.17,2009 by Liaoning Provincial Institute of Measurement (valid until Sep 16, 2010)<br>Sep.14,2010 by Liaoning Provincial Institute of Measurement (valid until Sep 13, 2011) |
| 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.* |
| QA/QC procedures applied: | *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.*<br>*Once a year, the flow meter is sent to a certified institute for external calibration (certificates are available for DOE)* |

| **Data / Parameter:** | $LFG_{flare, y}$ |
|---|---|
| Data unit: | $Nm^3$ |
| Description: | Amount of landfill gas flared |
| Measured/ Calculated /Default: | Measured |
| Source of data: | *Flow meter* |
| Value(s) of monitored parameter: | *5,212,888* |
| Indicate what the data are used for | *Used for baseline emission calculation.* |
| Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity) | Flow meter<br>Type: Annubar 285<br>Accuracy class: ±2%<br>Serial number: 01746509<br>calibration frequency: Every year<br>Date of calibrations: Sep.17,2009 by Liaoning Provincial Institute of Measurement (valid until Sep 16, 2010)<br>Sep.14,2010 by Liaoning Provincial Institute of Measurement (valid until Sep 13, 2011) |
| 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.* |
| QA/QC procedures applied: | *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.*<br>*Once a year, the flow meter is sent to a certified institute for external calibration (certificates are available for DOE)* |

| **Data / Parameter:** | $LFG_{electricity, y}$ |
|---|---|
| Data 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**:** | *7,704,232* |
| Indicate what the data are used for | *Used for baseline emission calculation.* |
| Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity) | Flow meter<br>Type: Annubar 285<br>Accuracy class: ±2%<br>Serial number: 01746510<br>calibration frequency: Every year<br>Date of calibrations: Sep.17,2009 by Liaoning Provincial Institute of Measurement (valid until Sep 16, 2010)<br>Sep.14,2010 by Liaoning Provincial Institute of Measurement (valid until Sep 13, 2011) |
| Measuring/ Reading/ Recording frequency: | *The data is measured and read continuously for the group of 3 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.* |
| QA/QC procedures applied: | *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.*<br>*Once a year, the flow meter is sent to a certified institute for external calibration (certificates are available for DOE)* |

| **Data / Parameter:** | $W_{CH4,y}$ |
|---|---|
| Data 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: | *About 50% (variable)* |
| Indicate what the data are used for | *Used for baseline emission calculation.* |
| Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity) | Gas Analyzer<br>Type: XGF-4043<br>Accuracy class: ≤2%<br>Serial number: 0708404<br>calibration frequency: Every year<br>Date of calibrations: Sep.18,2009 by Liaoning Provincial Institute of Measurement (valid until Sep.17, 2010)<br>Sep.13, 2010 by Liaoning Provincial Institute of Measurement (valid until Sep.12, 2011) |
| Measuring/ Reading/ Recording frequency: | *The data is measured continuously, recorded every 5 minutes, and archived electronically during the crediting period and two years after.* |
| QA/QC procedures applied: | *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.* |

| **Data / Parameter:** | $EL_{LFG}$ |
|---|---|
| Data 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: | *11,168,400* |
| Indicate what the data are used for | *Used for baseline emission calculation.* |
| Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity) | Electricity meter<br>Type: DSSD331-3<br>Accuracy class: 0.5s<br>Serial number: 8007472<br>calibration frequency: Every 3 years<br>Date of last calibration: Oct.12, 2008 by Power Metrology Institute of Liaoning Electric Power Co., Ltd. Shenyang Power Supply Company (valid until Oct 11, 2011) |
| 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.* |
| QA/QC procedures applied: | *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.* |

| **Data / Parameter:** | $EL_{PR}$ |
|---|---|
| Data unit: | *MWh* |
| Description: | *Total amount of electricity consumed* |
| Measured/ Calculated /Default: | Measured |
| Source of data: | ***2** Electricity meters* |
| Value(s) of monitored parameter: | Electricity meter A:*587.765*<br>Electricity meter B: 0 |
| Indicate what the data are used for | *Used for Project emission calculation.* |
| Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity) | **Electricity meter A**<br>Type: DTSD482<br>Accuracy class: 1<br>Serial number: 0103200014423<br>calibration frequency: Every 3 years<br><br>Date of calibrations:<br>Jul.17, 2006 by Su Jiatun Agro electricity Bureau Calibration and Testing Center (valid until Jul.16, 2011 as per the certificate)<br>Feb.19, 2009 by Su Jiatun Agro electricity Bureau Calibration and Testing Center (valid until Feb.18, 2014 as per the certificate)<br><br>**Electricity meter B**<br>Type: DTS51<br>Accuracy class: 1<br>Serial number: 0103200019480<br>calibration frequency: Every 3 years<br>Date of calibrations:<br>Jan.4, 2007 by Su Jiatun Agro electricity Bureau Calibration and Testing Center (valid until Jan.3, 2012 as per the certificate)<br>Jan.5,2009 by Su Jiatun Agro electricity Bureau Calibration and Testing Center (valid until Jan.4, 2014 as per the certificate) |
| 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.* |
| QA/QC procedures applied: | *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.* |

| **Data / Parameter:** | $T_{flare}$ |
|---|---|
| Data unit: | *°C* |
| Description: | *Temperature in Exhaust gas of enclosed flare* |
| Measured/ Calculated /Default: | Measured |
| Source of data: | *N-type Thermocouple* |
| Value(s) of monitored parameter: | *About 600°C (variable)* |
| Indicate what the data are used for | *Used for baseline emission calculation.* |
| Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity) | Thermocouple<br>Type: WRMK-331<br>calibration frequency: Replaced before one year from manufacturing (therefore no calibration is needed)<br>Dates of replacements: May 2, 2009 (Manufacturing date April 2009)<br>Apr 15, 2010 (Manufacturing date April 2010)<br>Apr 12, 2011(Manufacturing date April 2011) |
| Measuring/ Reading/ Recording frequency: | *The data is measured continuously, recorded every 5 minutes, and archived electronically during the crediting period and two years after.* |
| QA/QC procedures applied: | *Thermocouple is replaced by a new one every year to ensure accuracy.* |

| **Data / Parameter:** | EWH |
|---|---|
| Data 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: | *11,441* |
| Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity) | PLC, Programmable Logic Controller<br>Type: Siemens S7-300<br>Accuracy: Deviation per day: < 10 s |
| Measuring/ Reading/ Recording frequency: | *The data is measured continuously for the group of 3 engines, recorded every 5 minutes, and archived electronically during the crediting period and two years after.* |
| QA/QC procedures applied: | *Equipment is maintained in line with manufacturer recommendations to assure high quality output.* |

| **Data / Parameter:** | FWH |
|---|---|
| Data 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: | *11,532* |
| Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity) | PLC, Programmable Logic Controller<br>Type: Siemens S7-300<br>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.* |
| QA/QC procedures applied: | *Equipment is maintained in line with manufacturer recommendations to assure high quality output.* |

| **Data / Parameter:** | $PE_{flare}$ |
|---|---|
| Data unit: | $tCO_2$ |
| Description: | *Emission caused by methane not being destroyed in the course of flaring* |
| Calculated: | 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 **Tflare**. |
| Source of data: | |
| Value(s) of monitored parameter: | *4,122.63* |
| Indicate what the data are used for | *Baseline emission calculation.* |
| Monitoring equipment | *See* FV_RG,h , $fv_{CH4,RG,h}$ , Tflare |
| Measuring/ Reading/ Recording frequency: | |
| Calculation method (if Applicable): | *As per thje methodological "Tool to determine project emission from flaring gases containing methane"* |
| QA/QC procedures applied: | |

| **Data / Parameter:** | $fv_{CH4,RG,h}$ |
|---|---|
| Data 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: | *About 50% (variable)* |
| Indicate what the data are used for | *Used for* $PE_{flare}$ *emission calculation of baseline.* |
| Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity) | Gas Analyzer<br>Type: XGF-4043<br>Accuracy class: ≤2%<br>Serial number: 0708404<br>calibration frequency: Every year<br><br>Date of calibrations: Sep.18,2009 by Liaoning Provincial Institute of Measurement (valid until Sep.17, 2010)<br>Sep.13, 2010 by Liaoning Provincial Institute of Measurement (valid until Sep.12, 2011) |
| Measuring/ Reading/ Recording frequency: | *The data is measured continuously, recorded every 5 minutes, and archived electronically during the crediting period and two years after.* |
| QA/QC procedures applied: | *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.* |

| **Data / Parameter:** | $FV_{RG,h}$ |
|---|---|
| Data 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* |
| Indicate what the data are used for | *Used for* $PE_{flare}$ *emission calculation of baseline.* |
| Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity) | Flow meter<br>Type: Annubar 285<br>Accuracy class: ±2%<br>Serial number: 01746509<br>calibration frequency: Every year<br>Date of calibrations: Sep.17,2009 by Liaoning Provincial Institute of Measurement (valid until Sep 16, 2010)<br>Sep.14, 2010 by Liaoning Provincial Institute of Measurement (valid until Sep.13, 2011) |
| 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 applied: | *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.*<br>*Once a year, the flow meter is sent to a certified institute for external calibration (certificates are available)* |

*In order to measure the monitoring parameter of LFG normalized flow in three points (main, engines and flare pipe) the Project Participants have chosen Rosemount Annubar 285 flow meters fully integrated with a temperature sensor and a pressure sensor (pls. refer to the table "Data to be collected or used to monitor emissions from the project activity, and how this data will be archived" in ACM0001 – ver.6 – ID no. 7."T" and 8."p").*

*The instrument, working as a whole system which accurately and simultaneously measures i) differential pressure, ii) static pressure and iii) process temperature to dynamically calculate a compensated LFG flow, automatically renders as its output an LFG flow normalized to the standard conditions.*

*Furthermore, the declaration about the calibration issued by the manufacturer indicates that the most direct and effective calibration method is to install the flow meter in the pipe of the metrology lab (the third party), and calibrate it with the standard flow (calibration system for sonic nozzle is used commonly).*

*Therefore, the instrument was calibrated as a whole system and successfully got calibration reports of the normalized flow by the metrology institute, and the result issued by the metrology institute has already considered the influence of the temperature sensor and the pressure sensor.*

*Other Flare Operation Parameters:*
*As per the manufacturer's specifications, there is no other operating conditions of the flare that needs to be monitored.*

## SECTION E. Emission reductions calculation

The greenhouse gas emission reduction achieved by the project activity during a given period "y" ($ER_y$) is calculated by using the formulas as given in method ACM0001:

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

Where:

| | |
|---|---|
| $ER_y$ | = Emissions reduction, in tonnes of $CO_2$ equivalents ($tCO_{2e}$) |
| $MD_{project,y}$ | = Amount of methane that would have been destroyed/combusted during the year, in tonnes 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 tonnes of methane ($tCH_4$) |
| $GWP_{CH4}$ | = Global Warming Potential of methane ($tCO_{2e}/tCH_4$) |
| $EL_{LFG,y}$ | = Net quantity of electricity produced using LFG, exported which in the absence of the project activity would have been produced by power plants connected to the grid or by an on-site/off-site fossil fuel based captive power generation, during year y, in megawatt hours (MWh) |
| $CEF_{elec,B,y}$ | = $CO_2$ emissions intensity of the baseline source of electricity displaced ($tCO_{2e}$/MWh) |
| $EL_{PR,y}$ | = 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) |
| $CEF_{elec,PR,y}$ | = Carbon emissions factor for electricity generation in the project activity ($tCO_{2e}$/TJ) |
| $ET_{LFG.y}$ | = 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 (tonne) |
| $CEF_{ther,PR,y}$ | = $CO_2$ emissions factor of the fossil fuel used by boiler to generate thermal energy in the project activity during year y. |

### E.1. Baseline emissions calculation

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

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

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:

$ET_{LFG,y} = 0$

**Calculation of $MD_{project,y}$**

For the ER calculation, two are the main tools used:

I. The so called "master", the spreadsheet used in FDS for the $MD_{project}$ calculation ($CO_2$ avoided by destruction of methane by flaring or combustion in the engines).
II. The ER calculation spreadsheet (in Annex), where the results of the master (i.e. the reports from FDS) are put together with the calculations of the $CO_2$ avoided by energy production ($EL_{LFG,y}$*$CEF_{elec,BL,y}$) and $CO_2$ produced by energy consumption ($EL_{PR}$*$CEF_{elec,PR,y}$) to get the final result of ER.

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

- the sum of the quantities fed into the flare ($LFG_{flare,y}$), to the power plant ($LFG_{electricity,y}$) is compared with the total LFG captured ($LFG_{total,y}$);
- the lower value of the two is then adopted as $MD_{project,y}$ for a conservative approach.

This conservative approach of the lower value is applied in the column "J" of the sheets "OpDatasheet" of the *master* (MD calculation spreadsheet) on a 5 minutes basis (the most conservative).

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".
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 (column "H" of the "OpDatasheet" of the master):

- 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**<br>Apr. 01, 2010 –July.31, 2011 | **[$tCO_2$]** |
|---|---|
| **$PE_{flare,y}$** | 4,122.63 |

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

| **Monitoring Period**<br>**Apr. 01, 2010 – July.31, 2011** | [$tCO_2$] |
|---|---|
| **$MD_{project,y}$*$GWP_{CH4}$** | 96,226 |

**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**<br>Apr. 01, 2010 – July.31, 2011 | **[$tCH_4$]** |
|---|---|
| **$MD_{reg,y}$** | 0 |

**Calculation of $MD_{electricity,y}$**

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 net amount of electricity exported to China Northeast Electric Power Grid during this monitoring period is shown as follows:

| **Monitoring Period** | $EL_{LFG,y}$ [MWh] | $CEF_{elec,BL,}$ [$tCO_{2eq}$/MWh] | $EL_{LFG,y}$*$CEF_{elec,BL,y}$ **[$tCO_2$]** |
|---|---|---|---|
| Apr. 01, 2010 – July.31, 2011 | 11,168.4 | 1.05176 | 11,746.48 |

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

## E.2. Project emissions calculation

According to the applicable methodologies, the project emissions ($PE_y$), achieved by the project activity for this monitoring period are calculated as follows:

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

Where:

- $PE_y$ =Project emissions reduction, in tons of $tCO_2$ equivalent ($tCO_{2eq}$)
- $CEF_{elec,PR,y}$ = 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)
- $ET_{PR,y}$ = 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:

$ET_{PR,y} = 0$

The net amount of electricity imported from Northeast China Grid 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] | $EL_{LFG,y}$*$CEF_{elec,PR,y}$ **[$tCO_2$]** |
|---|---|---|---|
| Apr. 01, 2010 – July.31, 2011 | 587.765 | 1.05176 | 618.19 |

## E.3. Leakage calculation

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

## E.4. Emission reductions calculation / table

**Total baseline emissions:**

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

| Monitoring Period | $MD_{project,y}$* $GWP_{CH4}$ [$tCO_2$] | $MD_{reg,y}$ *$GWP_{CH4}$ [$tCO_2$] | $EL_{LFG,y}$* $CEF_{elec,LFG,y}$ [$tCO_2$] | $ET_{LFG.y}$* $CEF_{ther,LFG,y}$ [$tCO_2$] | $BE_y$ [$tCO_2$] |
|---|---|---|---|---|---|
| Apr. 01, 2010 – July.31, 2011 | 96,226 | 0 | 11,746.48 | 0 | 107,972 |

Note: In a conservative discipline, the baseline emission amount is rounded down.

**Total project emissions:**

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

| Monitoring Period | $EL_{PR,y}$* $CEF_{pr,PR,y}$ [$tCO_2$] | $ET_{PR,y}$* $CEF_{ther,PR,y}$ [$tCO_2$] | $PE_y$ [$tCO_2$] |
|---|---|---|---|
| Apr. 01, 2010 – July.31, 2011 | 618.19 | 0 | 619 |

Note: In a conservative discipline, the project emissions is rounded up.

**Total leakage:**

There is no leakage in this project.

**Total emission reductions:**

$ER_y = BE_y - PE_y$

| Monitoring Period | $BE_y$ [$tCO_2$] | $PE_y$ [$tCO_2$] | $ER_y$ [$tCO_2$] |
|---|---|---|---|
| Apr. 01, 2010 – July.31, 2011 | 107,972 | 619 | 107,353 |

## E.5. Comparison of actual emission reductions with estimates in the CDM-PDD

According to PDD estimate CERs in year 2010 and 2011 should have been equal to 103,628 $tCO_2$ and 112,753 $tCO_2$ respectively. Referring to the present Monitoring Period this means, as the length of the monitoring period is about 9 months in 2010 and 7 months in 2011:

ER expected (Apr. 01, 2010 –Dec.31, 2010) = (103,628/365)*275 = 78,075.89 $tCO_2$

ER expected (Jan.1, 2011 –Jul.31, 2011 = (112,753/365)*212 =65,489.41 $tCO_2$

| Item | Values applied in ex-ante calculation of the registered CDM-PDD ($tCO_2e$) | Actual values reached during the monitoring period ($tCO_2e$) |
|---|---|---|
| **Emission reductions ($tCO_2e$)** Apr. 01, 2010 – July.31, 2011 | 143,565.3 | 107,353 |

## E.6. Remarks on difference from estimated value in the PDD

The actual emission reductions claimed in this period are lower than PDD estimate.

## Annex 1. Additional monitoring information

I.Monitoring Sheets for Shenyang Laohuchong LFG Power Generation Project (01/04/2010 00:00—01/08/2011 00:00);

II. Spreadsheet for ER calculations;

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