CLEAN DEVELOPMENT MECHANISM
PROJECT DESIGN DOCUMENT FORM (CDM-PDD)
VERSION 03 - IN EFFECT AS OF: 28 JULY 2006

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Annexes

SECTION A. General description of project activity

A.1. Title of the project activity:

"Shenyang Laohuchong LFG Power Generation Project".
Version 03 – 16 June 2008.

A.2. Description of the project activity:

The purpose of the project is to capture and burn biogas, generating electricity, at the Shenyang Laohuchong Municipal Solid Waste landfill in China. Laohuchong landfill receives approximately 355,900 tons per year of domestic and non-hazardous industrial waste. The area used for landfilling is 602,470 m^2. The landfill has started its operation in 2003 and will be closed on 2025. The project will have an electricity component with an installed capacity reaching 3 MW.

The quantity of waste entering the landfill is described in the table below.

Tab. A. 1: Waste Disposal Input Units for Shenyang Laohuchong Municipal Solid Waste Landfill.

Year	Tonnes of urban solid waste entering the landfill every year
2003	226,590
2004	358,848
2005	402,758
2006	355,875
2007	355,875
2008	355,875
2009	355,875
2010	355,875
2011	355,875
2012	355,875
2013	355,875
2014	355,875
2015	355,875
2016	355,875
2017	355,875
2018	355,875

The project is based on two complementary activities, the extraction and flaring of landfill gas and the electricity generation and displacement to the grid that will effect a reduction in greenhouse gas emissions through two different ways:

- the destruction of the methane
- the reduction of a certain amount of fossil fuel used to generate electricity that will be substituted by the electricity generated in the biogas plant

The biogas produced will be burnt by setting up and operating an extraction plant comprised of a network of wells and connected pipes, running into blowers and then into torches to flare it, and into generators to

generate electricity. In this way, not only methane emissions will be reduced, but also 3 MW of renewable energy installed capacity will be exploited.
The project is expected to generate 1,365,700 tCO_{2e} in 10 years due to the methane destruction and electricity displacement. The project has chosen the fixed crediting period based on the "*Contract to develop the* Shenyang Laohuchong LFG Power Generation Project" agreement signed with the Shenyang Laohuchong Municipal Solid Waste Management Co. Ltd.

This proposed project will contribute to the sustainable development of the area immediately surrounding the landfill due to the following reasons:

- Abatement of the CH_4 emissions from the landfill.
- Generation of zero-emission electricity. The project will become a grid supplier of renewable energy because it will use biogas instead of fossil fuel to generate electricity. This will contribute to one of the China's goals for promoting the sustainable developing, which is to diversify the sources of electrical generation.
- The area immediately surrounding the landfill will see an immediate benefit in the elimination of gas emissions coming from the landfill. Substantial reduction or elimination of noxious gases will improve local environment and mitigate the health risks (nuisance, etc.) that are associated to these emissions and affect the local population.
- Safe and effective extraction of the biogas produced by the landfill, will minimizes the landfill gas migration, and then reduce the risks of fire and explosion at the landfill that are related to inappropriate landfill gas network collection.
- The project will have a small but positive impact on local economy, employing and training local workers that will be required for construction, operation and maintenance of the plant; and using local materials for plant construction whenever possible.
- Considering knowledge on this kind of project is still not well developed in China, the project will have a great impact through technology transfer of clean technologies. On the other hand, it will provide know-how transfer as it will become a model that will contribute to spread knowledge on the exploitation of the biogas potential in China's landfills.

In China there are a lot of landfills that generate biogas and the realization of this project could be an example about how this kind of plants can be realized to improve the environment, as the project is fully replicable.

A.3. Project participants:

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

Tab. A. 2: Project participants.

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) (Buyer of CERs)	No

A.4. Technical description of the project activity:

A.4.1. Location of the project activity:

Tashan Farm, Chenxiang Town, Su Jiatun District, Shenyang, Liaoning, People's Republic of China.

A.4.1.1. Host Party(ies):

People’s Republic of China.

A.4.1.2. Region/State/Province etc.:

Liaoning Province.

A.4.1.3. City/Town/Community etc:

Shenyang City.

A.4.1.4. Detail of physical location, including information allowing the unique identification of this project activity (maximum one page):

The landfill site is located at approximately 28 km from Shenyang city. The coordinates for the project activity are: 41°33' N and 123°34 E. There are no towns closest to the area of the landfill, just a village which is situated at a distance of 4 km from the Laohuchong landfill.

Fig. A.1: Map of China.

Fig. A.2: Map of Liaoning.

Fig. A.3: Dislocation of Shenyang.

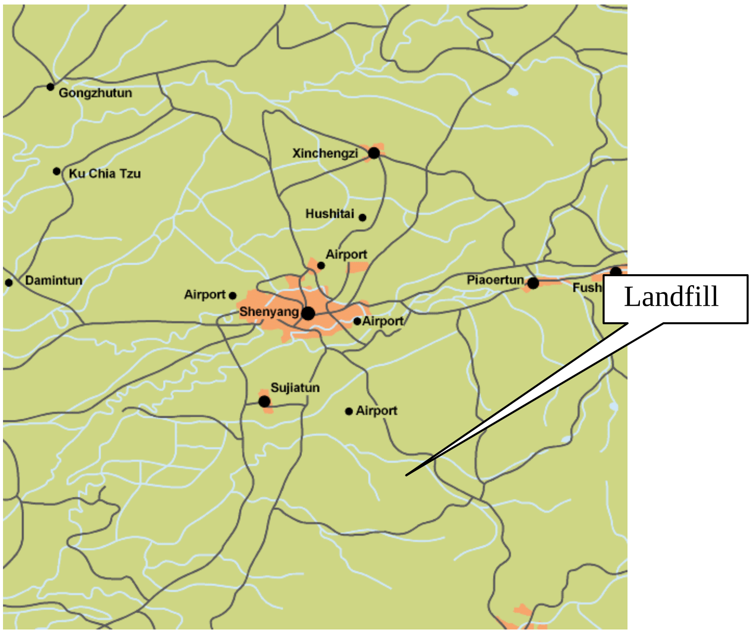


Fig. A.4: Shenyang Laohuchong Municipal Solid Waste Landfill.

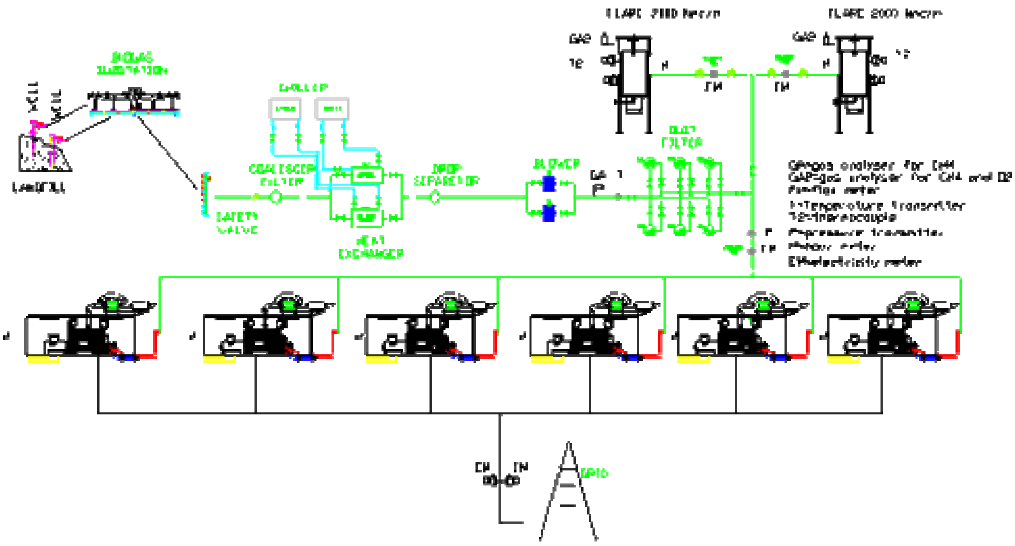
A.4.2. Category(ies) of project activity:

Project activity: 1 – Energy industry (renewable and non-renewable sources)
Project activity: 13 – Waste handling and disposal.

A.4.3. Technology to be employed by the project activity:

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

Fig. A.5: Biogas plant for a landfill.



Gas Extraction System

Biogas collection facility

(1) Vertical biogas collection well

The vertical biogas collection well consists of nonporous pipe and porous pipe. The lower end and upper end of the collection well are, respectively, porous pipe and nonporous pipe. The nonporous pipe is designed over 3 meters above ground in order to prevent air coming into. Meanwhile, the broken stone is packed between porous pipe and garbage layer, so as to prevent the porous pipe from being blocked by dropped garbage.

The vertical gas collection well is designed to be (at least) more than 4m from impermeable layer. Distance between two vertical biogas collection wells shall be kept at 30m from each other. The biogas collection rate remains 40% since the biogas is collected under low pressure.

(2) Well-header and branch pipe for biogas collection
The well-header is connected to 10-12 vertical biogas collection wells through the biogas collection branch pipe around, which is designed to regulate the biogas state in each biogas collection well.
The biogas collected by each well-header is conveyed by the master pipe via transportation pipe network to the biogas treatment system for filtration, cooling, condensed water-removal and pressurization before being used as fuel in power generation.

Biogas treatment system

The filtration, cooling, condensed water-removal, pressurization and accidental discharge, etc. are included in the biogas treatment system.

Filtration, cooling and condensed water-removal system of biogas
The substantial quantities of hazardous ingredients (including water, dust, H_2S, silica and NH_3, etc.) are contained in biogas, if such ingredients not being purged away from the biogas, the service life of collection pipeline and generators, etc, will be shortened due to the corrosion impact. The system of biogas filtration, cooling and condensed water-removal is primarily designed to remove from biogas the water, H_2S, NH_3, silica and dust, etc. which are harmful to the biogas generators.

The system of biogas filtration, cooling and condensed water-removal is mainly composed of primary filter, biogas cooler, liquid chiller, secondary filter, dry filter and collector of condensed water, etc.

The biogas collected in the landfill site is conveyed into the biogas treatment system via the transmission pipeline. After being purged away water drop and granule dusts through the preliminary filtration of primary filter, the biogas is cooled down below 2℃ in the biogas cooler, with water and ethylene glycol as cooling medium. The condensed water in substantial quantity together with some impurities (comprising sulfide, aromatic hydrocarbon and halides, etc.) is separated out. The biogas containing condensed water and impurities will undergo the process of cyclone separation in the secondary cyclone separator, with the condensed water and impurities removed away. After being boosted by the biogas pressurization system, the biogas is purged by the dry filter of particulate pollutants harmful to biogas generators. The biogas that is fed into generators can thus be guaranteed qualitatively, without damage caused to biogas generators by the pollutants. The service life of power generators can thereby be extended.

Biogas pressurization system

The biogas pressurization system is composed of the methane analyzer and gas blower set. The methane analyzer is mounted on the pipeline before the dry filter, in order to detect the composition of biogas into the power generator.

Biogas treatment equipment

Condensed water trap
The cylinder-shaped condensed water trap is designed to collect and purge away the condensed water from landfill biogas, the size of which varies with the power generation capacity. The condensed water trap in this project is 3 m high, with an inner diameter of 0.71 m.

Biogas cooler
The biogas, after condensed water being removed, undergoes the forced cooling by means of heat exchange in the biogas cooler, with its temperature reduced below 2℃. The water can thus be separated out from biogas.

Liquid chiller
The liquid chiller is designed to provide cooling medium for the biogas cooler and to make possible the recycling of cooling medium. To keep the cooling medium at a certain temperature, the thermometer and pressure gauge are mounted on each exhausting pipe in order to control the temperature of recycling cooling medium.

Biogas filter
The biogas filter is arranged in the first and final steps of the biogas treatment system, comprising primary filter, secondary filter as well as dry filter. The filter is designed to purge biogas of hazardous impurities, in an effort to ensure the quality of biogas to be into the power generator. The damage caused by pollutants to biogas power generators can thus be avoided, with the service life of power generators extended as a result.

Biogas blower set
The biogas blower set is interlocked with gas-fired power generator through pressure transmitter, with variable frequency control exercised as well. The flow and pressure of biogas into the biogas blower set are adjusted depending on the varying composition of biogas, so that the biogas blower set can match with the operation of gas-fired generator.

Biogas power generation system
The gas fuelled engines are produced by the Jinan Diesel Engine Limited Liability Company. Efficiency of set can reach 30-33%.
The 500GF-NK methane power set uses the digital intellectualization ignition module, the generator uses not brushes the excitation automatic accent piezoelectricity machine, controls the cabinet to use the self-synchronization and the load assignment module, and has the complete safekeeping of security system.

Control of gas-fired power generating set
The control of gas-fired power generating set is exercised through the computer in the master control room.

Manual local control is used for start-up of power generating set, and its stopping is controlled locally or on the control panel of computer. On the control panel of the computer, load of the generator can be regulated based on signals of CH_4 content from biogas analyzer and biogas pressure from the biogas blower set. Also, the panel can display detection results with respect to status, alarm, pressure and temperature of various functions.

The alarm warning is given once the major values (such as temperature, pressure, concentration of CH_4 and O_2, etc.) exceed the preset values. Meanwhile, the operation of generators is stopped for protection purpose.

If the parameters of major protective functions, such as temperature of cooling water, temperature and pressure of lubricating oil, output voltage, output frequency, short circuit fault, over-speed, single phase earthing, output over-load, and so on exceed the preset values, the relay that is designed to protect the generator will start the alarm warning and stop the generator at the same time.

The power generating set will be automatically adjusted to the maximum power capacity or preset capacity, in light of the different fuels and external conditions following start-up of generators. The load can be automatically increased or reduced based on different conditions.

Biogas conveying pipe network in the plant area
Biogas conveying pipe network is connected to biogas collecting master pipe to biogas preliminary treatment facility in the main building of power generation station. Biogas conveying pipe network is laid along treatment area ground as variation with landform. The lower support laying is adopted. In order to prevent biogas-conveying pipe being frozen in winter, insulation and adjoining heat measures should be taken. Rock wool is adopted as the insulation material, and pipe material is high-density polyethylene (HDPE). The special connecters of HDPE are adopted for connecting fittings of pipe.

Control and protection
Control and protection of 10kV transformer and distribution substation will be controlled by computers and will be supplied completely with power generating sets.

Technical description of the main equipments:
For safety reasons two flares of 2,000 Nm^3/h will be installed. The flares will achieve a combustion temperature of 800 - 1,000°C, a temperature of the exhaust gas of the flare above 500°C and a retention time higher than 0.3 s and the burning efficiency according to the manufacturer's specifications is higher than 98%. The model number is TOR-30-A1; HBKB-120P-A1. The manufacturer will be Shunfeng – Pioneer.

Concerning the power plant, six engines of 500 kW, type: 500GF-N G12V190ZLDZ－2 will be installed. The manufacturer will be JDEC, Jinan Diesel Engine Co. limited

The project involves the introduction of a not well-known technology and a foreign know-how in China which is helpful because it means a technological transfer.

A.4.4 Estimated amount of emission reductions over the chosen crediting period:

Year	Annual Estimation of emission reductions in tonnes CO_{2e}
2009	88,156
2010	103,628
2011	112,753
2012	126,207
2013	135,037
2014	142,354
2015	154,891
2016	161,698
2017	167,687
2018	173,288
Total estimated reductions: (tonnes of CO_{2e})	**1,365,700**
Total number of crediting years:	10
Annual average over the crediting period of estimated reductions: (tonnes of CO_{2e})	136,570

A.4.5. Public funding of the project activity:

No public funding will be utilized.

SECTION B. Application of a baseline and monitoring methodology

B.1. Title and reference of the approved baseline and monitoring methodology applied to the project activity:

The baseline and monitoring methodologies used are:

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

The "*Tool for the demonstration and assessment of additionality - Version 4*" is applied to show that CDM assistance is required for the project activity to be successfully implemented.
Besides the "*Tool to determine project emissions from flaring gases containing methane*" was used, in accordance with the ACM0001 methodology, to calculate the projects emissions from flaring.

Please for detailed information, refer to UNFCCC CDM Executive Board website in the following link: http://cdm.unfccc.int/methodologies/PAmethodologies/approved.html

B.2 Justification of the choice of the methodology and why it is applicable to the project activity:

ACM0001 (Version 06): is applicable to the following situations in regards to LFG activities where:

A. The captured gas is flared; or
B. The captured gas is used to produce energy (e.g. electricity/thermal energy),
C. The captured gas is used to supply consumers through natural gas distribution network.

The project activity corresponds to A) and B) above and is therefore applicable according to ACM0001.

ACM0002 (Version 06): is applicable to grid-connected renewable power generation project activities amongst others under the following conditions:

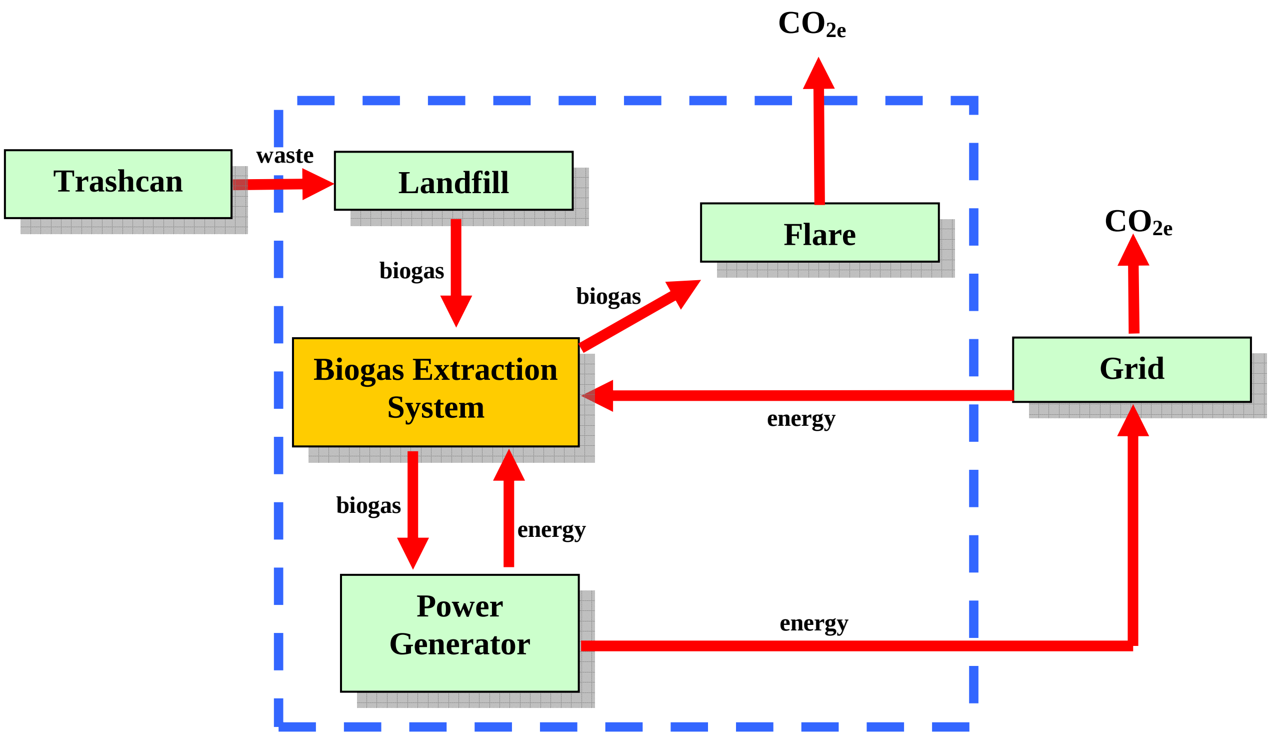
A. Is applied to grid connected electricity generation from landfill gas capture to the extent that it is combined with the approved "Consolidated baseline methodology for landfill gas project activities" (ACM0001).
B. The geographic and system boundaries of the Power Grid can be clearly identified and information on the characteristics of the gird is available
C. The proposed project does not involve switching from fossil fuels to renewable energy at the site.

The project activity corresponds to the situation described above and is therefore applicable to ACM0002.

B.3 Description of the sources and gases included in the project boundary:

The project boundary is the site of the project activity where the gas is captured, destroyed and/or used. Furthermore, according to methodology ACM0002, the project boundary encompasses the physical, geographical site of the renewable generation source.
Currently the State Grid conducts electricity dispatch across regional grids. Each regional grid takes care of dispatching within its own area. North East Electric Power Grid is one of these large grids in China.
According to methodology ACM0002, North East Electric Power Grid is chosen as electric system for this project, and project boundary includes all the plants connected to it.

Fig B. 1: CDM Project Activity.



Tab. B. 1: Sources and gases included in the project boundary.

	Source	Gas	Included?	Justification / Explanation
Baseline	LFG venting	CO_2	No	It is not considered because it is part of the natural carbon cycle
		CH_4	Yes	Calculated in baseline emissions
		N_2O	No	Not applicable
	Fossil-fuel power plants connected to the grid	CO_2	Yes	Since the methodology ACM0002 is used, only CO_{2e} emissions from electricity generation in fossil fuel fired power plants, that is displaced due to the project activity shall be included
		CH_4	No	Not applicable
		N_2O	No	Not applicable
Project Activity	Landfill	CO_2	No	It is not considered because it is part of the natural carbon cycle
		CH_4	No	Not considered as part of the project as the emission of methane are not considered in the baseline scenario
		N_2O	No	Not applicable
	Flare	CO_2	No	CO_2 emissions from landfill gas combustion are of biogenic origin and are therefore not considered as GHG emissions
		CH_4	Yes	For baseline emissions calculation, it is assumed that part of the methane entering the flare is not destroyed.
		N_2O	No	Not applicable
	On-site electricity consumption due to the project activity	CO_2	Yes	The project will use energy for the plant operation, that will be taken from the grid.
		CH_4	No	Not applicable
		N_2O	No	Not applicable

B.4. Description of how the baseline scenario is identified and description of the identified baseline scenario:

Methodology ACM0001 version 6 established the procedures for the selection of the most plausible baseline scenario. According to it two steps should be followed:

STEP1: Identification of alternative scenarios

Sub-step 1a. Define alternative scenarios

The baseline scenario is defined as the most likely future scenario in the absence of the proposed CDM activity.

Relevant policies and circumstances will be monitor on an annual basis in order to detect national or local regulation changes that can modified the baseline of the project activity.

Alternative scenarios are considered as follows:

LFG1. The project activity (capture of landfill gas and its flaring and use for electricity generation) undertaken without being registered as a CDM project activity;
LFG2. Atmospheric release of the landfill gas or partial capture of landfill gas and destruction to comply with regulations or contractual requirements, or to address safety and odour concerns.

LFG1 is not realistic. In the absence of a CDM project being developed at the landfill site, LFG revenues (electricity) are insufficient to recover the project investments and operational costs for the flaring and power generation (this is further explained in section B.5 "financial analysis")

Except the simple control facilities avoiding explosion of methane aggregation[1], Chinese government does not mandate to flare or collect the LFG emitted from landfills and most landfills in China are releasing LFG directly to the atmosphere without any previous treatment or utilization. Landfill gas release entirely into the atmosphere (LFG2) is the common practice in China.

For electricity generation, the realistic and credible alternatives include:

P1. Power generated from landfill gas undertaken without being registered as CDM project activity;
P2. Existing or Construction of a new on-site or off-site fossil fuel fired cogeneration plant;
P3. Existing or Construction of a new on-site or off-site renewable based cogeneration plant;
P4. Existing or Construction of a new on-site or off-site fossil fuel fired captive power plant;
P5. Existing or Construction of a new on-site or off-site renewable based captive power plant;
P6. Existing and/or new grid-connected power plants.

Other renewable sources are not applicable to the project site and/or there is a lack of renewable energy source in the area, so options P3 and P5 are not credible alternatives to the baseline scenario.

Moreover, without CDM or financial support, there is no economic incentive for LFG collection and electricity generation system. Electricity revenues do not cover all the investment and operational costs required for power generation from landfill gas, therefore is hardly possible that the project owner will be able to afford to install the necessary equipments. Projects comparable with the projects activity in China have been carried out due to the assistance received from international funds (this is further described in the "common practice" section). Alternative P1 is not a realistic alternative.

For heat generation, the realistic and credible alternatives are:

H1. Heat generated from landfill gas undertaken without being registered as CDM project activity;
H2. Existing or Construction of a new on-site or off-site fossil fuel fired cogeneration plant;
H3. Existing or Construction of a new on-site or off-site renewable based cogeneration plant;
H4. Existing or new construction of on-site or off-site fossil fuel based boilers;

[1] National Action Plan for Collection and Utilization of Landfill Gas (12/2001)
http://www.people.com.cn/GB/huanbao/55/20021030/854345.html.
Technical Code for Sanitary Landfill of Municipal Domestic Refuse (CJJ17-2001) Standard for Pollution Control on the Landfill Site for Domestic Waste (GB16889-1997)

H5. Existing or new construction of on-site or off-site renewable energy based boilers;
H6. Any other source such as district heat; and
H7. Other heat generation technologies (e.g. heat pumps or solar energy).

As stated before, other renewable sources are not applicable to the project site and there is a lack of renewable energy source in the area, so options H3 and H5 are discarded. Besides, alternative heat generation technologies require great investment and skilled personnel making alternative H6 and H7 not competitive with conventional coal/electricity based heat generation systems. These are not considered realistic and credible scenarios.

Moreover, landfills are usually constructed in territory far away from the downtown in order to minimize the environmental impacts in local population. Shenyang Laohuchong landfill is about 28 km from the nearest potential consumer of a scale big enough to meet the project supply. Alternative H1 would require a large initial investment in pipelines and thermal installation that could hardly be afforded by the project owner without CDM or financial support. Therefore, alternative H1 is not realistic and plausible baseline scenario.

Regarding alternative H4, fossil fuel boilers are not regulated by law. In the absence of the project activity, the potential consumers of heat, to be supply by the project activity, would continue to use their fossil fuel based boilers already installed.

Sub-step 1b. Consistency with mandatory laws and regulation

According to Chinese regulations coal fired power plants of less than 135MW are prohibited for construction in the areas covered by the large grids such as provincial grids. Moreover, the construction of thermal units under 100MW is strictly limited[2] in China, so alternatives P2, P4 and H2 are not plausible baseline scenarios.

Even though the state calls on best utilization of LFG, due to various barriers, generally it is not implemented; most directions are focused on safety aspects but not on enforcing regulations regarding LFG extraction and/or treatment. There are no legal and/or regulatory requirements that enforces to capture and use the landfill gas in China.
The rest of the baseline scenarios comply with all laws and regulations but they are not required by law.

The baseline scenario for the project activity is:

Scenario	Baseline			Description of situation
	Landfill gas	Electricity	Heat	
	LFG2	P6	H4	The atmospheric release of landfill gas to the atmosphere. The electricity is obtained from an existing/new grid-connected power plant and heat from an existing/new fossil fuel based boiler.

[2] Prescribe on construction and supervise of the small scale thermal power generation units, August 1997. Chinese new energy website http://www.newenergy.org.cn/html/2006-2/2006217_7650.html.

STEP 2: Identified the fuel for the baseline choice of energy source taking into account the national and/or sectoral policies applicable

The main energy source and thus, the baseline fuel, in all power grids is China is coal. Coal is available in abundance in China and there is no supply constraint.
Regarding the North East Electric Power Grid, as described in Annex 3, 98.89% of the energy sources is coal based.

The fuel for the baseline choice of energy source is coal.

B.5. Description of how the anthropogenic emissions of GHG by sources are reduced below those that would have occurred in the absence of the registered CDM project activity (assessment and demonstration of additionality):

CDM revenues were seriously considered in the decision to go ahead with the project activity. The project owner held a Board Meeting on November 24th, 2005. During that meeting he authorized the design institute to write the FSR which was issued on May 2007.
On December 8, 2005 the project participants signed contract. The FSR was approved on June 15, 2007 and the starting date of the project activity, as the starting construction date, was on July 01, 2007.

According to the requirement of consolidated methodology ACM0001, the *"Tool for the demonstration and assessment of additionality - Version 4"* should be applied in a conservative and transparent manner to show that CDM assistance is required for the project activity to be successfully implemented.
Besides, ACM0001 requires that the additionality test shall be applied for each alternative of the baseline considered in the baseline determination.

The "*Tool for the demonstration and assessment of additionality*" foresees four steps:
Step 1: Identification of alternatives to the project activity consistent with current laws and regulations.
Step 2: Investment analysis
Step 3: Barrier analysis
Step 4: Common practice analysis

The steps 1 and 2 will be followed for each alternative separately in order to demonstrate additionality. Then step 4 will be applied.

The alternatives scenarios to the proposed project were divided in three groups: alternative LFG scenarios, alternative power generation scenarios and alternative heat generation scenarios.

1. **Alternative LFG scenarios**

Step 1. Identification of alternatives to the project activity consistent with current laws and regulations.

Sub-step 1a. Define alternatives to the project activity.
LFG1. The project activity (capture of landfill gas and its flaring and use for electricity generation) undertaken without being registered as a CDM project activity;
LFG2. Atmospheric release of the landfill gas or partial capture of landfill gas and destruction to comply with regulations or contractual requirements, or to address safety and odour concerns.

Sub-step 1b. Enforcement of applicable laws and regulations.
Both scenarios comply with the applicable laws and regulations. There is no contractual requirement or regulation that enforces to capture and destroy the landfill gas.

Step 2. Investment Analysis
As stated on B.4 LFG1 is not likely to happen in the absence of a CDM project being developed at the landfill site since LFG revenues (electricity) are insufficient to recover the project investments and operational costs of the project. The investment analysis below shows that it is not possible to develop the project without CDM benefits.

Sub-step 2a: Determine appropriate analysis method.
The project will have proceeds from power sales as well as from emission reduction credits, so Option I stated in "*Tool for the Demonstration and Assessment of Additionality" (version 4)* is not applicable.
Option II is based on the comparison of returns of the project investment with the investment required for an alternative to the project. In this case, the alternative to the CDM project activity is simply not to install flaring and generation equipment at the site, and therefore does not involve investments of comparable scale to the project. Consequently, Option II is not applicable to this project.
Option III must be used, where the returns of the investment in the project activity is compared to benchmark returns that are available to any investor in the country.

Sub-step 2b: Option III - Apply benchmark analysis
The IRR was chosen as the relevant financial indicator for the Project.
The likelihood of development of this project, as opposed to the continuation of current activities (i.e. no collection and combustion of LFG) will be determined by comparing its IRR with the benchmark of interest rates available to a local investor.
With reference to *Interim Rules on Economic Assessment Electrical Engineering Retrofit Projects*, the financial benchmark of return of Chinese power industries accounts for 8% of the total investment IRR. The project involves the construction of a biogas plant for electricity generation which is a relative new type of investment area and can be compared to power industries. Besides, since it is not a common practice in China, there are more operational, technological and market risks than a conventional power industry, therefore, this benchmark rate of return is considered to be conservative.

Sub-step 2c: Calculation and comparison of financial indicators.
The Tables below show the financial analysis for the project activity. As shown, the project IRR (without carbon finance) is negative, therefore lower than any rate of return available to investors in China.
These results show that project is still not an economically attractive course of action without the sale of CERs.
For IRR calculation the input number are the revenue, variable costs, depreciation, income tax and investment. The cash flow result is provided in the following tables:

Tab. B. 2: Main financial data

Financial parameters	
Annual average output (MWh)	20,056,821
Total electricity delivered to the grid (MWh)	280,795,500
Expected electricity sale (Euro/kWh)	0.0597
Average installed capacity (MW)	2,5
Total investment (Euro)	4,182,116
Life time of this project (years)	14
Crediting period (years)	10
VAT (%)	17
Depreciation rate	10%
Annual operation cost (Euro/MWh)	0.035

Tab. B. 3: Financial analysis result

Revenue Analysis	Revenue without CER	Revenue with CER (10 USD/ton)
CER Price (Euro/ton)	€ 0	€ 7.69
Total investment IRR	4.36%	20.24%

Sub-step 2d: Sensitivity analysis.
Sensitivity analysis is conducted in order to assess whether the conclusion regarding the financial attractiveness is robust to reasonable variations in the critical assumptions. The most suitable financial indicators in this project are the total investment, the electricity revenue and the operation cost.
The table below shows how these parameters should vary in order to reach the benchmark.

Tab. B. 4: Sensitivity analysis.

Financial Parameter	Variation to the financial indicators needed to reach the 8% benchmark
Floating total investment	-24.45%
Electricity revenue	12.65%
Operation cost (O&M)	-19.45%

As it can be seen the variations obtained are not realistic scenarios:

- **Floating total investment**: The cost of the equipment installed in the biogas plant for the power generation depends on international prices. The market trend in the last years show that the prices grow up due to the increase in the costs of raw material, for this reason, it is not likely that the total investment can decrease in 24.45%and reach the 8% benchmark.

- **Electricity revenue**: The price of the electricity is published by the *"Provincial Electricity Exchanger Centre"* in the Liaoning Province. The price is made up by two parts: the "local benchmarking price" that depends on the Province (Liaoning has a price of 0.247[3] RMB/kWh) and a "subsidy price" of 0.25[4] RMB/kWh, which is granted to renewable energy power generation units. The "subsidy price" is fixed and does not change while the "benchmarking price" varies between 0.24 and 0.38 RMB/kWh in China. Even though, it is unlikely that the electricity tariff will change in a way increases the electricity price of 12.65%, hence the electricity revenues and make the project reach the 8% benchmark.

- **Operation costs**: The sensitivity analysis shows that the operation costs should decrease of 19.45% in order to reach the benchmark. Operation costs are calculated based on the necessary activities that must be carried out in order to maintain the operation of the plant in a level that guarantees the required working conditions and performance of the plant. A decrease in the operation costs (which means in the scheduled maintenance and/or in the staff in charge of this activity) could lead to a reduction in the performance of the plant and consequently not achievement of the expected production; for this reason, it is unlikely that the operation costs are reduced and reach the benchmark.

It can be seen just in the situations of very favorable scenarios (but hardly realistic) it would be possible to reach the 8% benchmark. The IRR is quite lower than the benchmark based on realistic assumptions so alternative LFG1 cannot be considered as financially attractive without the support of the CDM benefits.

[3] National Development and Reform Commission Issued the Issue on Questions Pertaining to Northeast Networks Implementation of Burning Coal Price Movement

[4] The Tentative Regulation for the Pricing of Renewable Sources Generating Electrical Energy and Costs Distribution.

2. Alternative power generation scenarios

Step 1. Identification of alternatives to the project activity consistent with current laws and regulations.

Sub-step 1a. Define alternatives to the project activity.
P1. Power generated from landfill gas undertaken without being registered as CDM project activity;
P2. Existing or Construction of a new on-site or off-site fossil fuel fired cogeneration plant;
P3. Existing or Construction of a new on-site or off-site renewable based cogeneration plant;
P4. Existing or Construction of a new on-site or off-site fossil fuel fired captive power plant;
P5. Existing or Construction of a new on-site or off-site renewable based captive power plant;
P6. Existing and/or new grid-connected power plants.

Alternative P1 is similar to alternative LFG1 (project activity) without considering flaring. Flaring in alternative LFG1 will just be done when the engines are not running in order to destroy the methane emissions efficiently. In the absence of flares (alternative P1) all that biogas would be freely emitted into the atmosphere increasing the emissions of greenhouse gases. Alternative P1 involves higher emission into the atmosphere and lower investment (biogas system is not installed). For this reason alternative P1 will be no further considered as an alternative project scenario and just LFG1 will be further analyzed.

A CDM project activity is additional if anthropogenic emissions of greenhouse gases are reduced below those that would have occurred in the absence of the registered CDM project activity. Existing grid connected power plants are coal based (as it can be seen in the EF analysis in Annex 3) while the project uses a renewable fuel (biogas). Under this situation alternative P6 can not be considered an alternative to the project activity.

Other renewable sources can not be considered alternatives to the project activity since they are not applicable to the project site and/or there is a lack of renewable energy source in the area, apart from the biogas from the landfill site that would continue to be emitted into the atmosphere if other source is used to generate electricity. Options P3 and P5 are not credible alternatives to the project activity and will not be further considered.

Sub-step 1b. Enforcement of applicable laws and regulations.
Taking into account the capacity that can generate the same annual electricity generation as the project activity, the alternative scenario for the proposed project should be a grid-connected fossil fuel fired power plant with installed capacity less than 1.5MW. However, according to Chinese regulations, coal fired power plants of less than 135MW[5] are prohibited for construction in the areas covered by the large grids such as provincial grids. Moreover, the construction of thermal units under 100MW is strictly limited[6]. Alternative P2 and P4 are not in compliance with China's relevant laws and regulations, so are not a realistic and credible alternative and will not be further analysed.

[5] Notice of the General Office of the State Council concerning the Strict Prohibition of the Construction of Thermal Power Units with a Capacity of 135MW or below, issues by the General Office of the State Council, Guo Ban Fa Ming Dian [2002] Document No.6.
[6] Prescribe on construction and supervise of the small scale thermal power generation units, August 1997. Chinese new energy website http://www.newenergy.org.cn/html/2006-2/2006217_7650.html.

3. Alternative heat generation scenarios

Step 1. Identification of alternatives to the project activity consistent with current laws and regulations.

Sub-step 1a. Define alternatives to the project activity.
H1. Heat generated from landfill gas undertaken without being registered as CDM project activity;
H2. Existing or Construction of a new on-site or off-site fossil fuel fired cogeneration plant;
H3. Existing or Construction of a new on-site or off-site renewable based cogeneration plant;
H4. Existing or new construction of on-site or off-site fossil fuel based boilers;
H5. Existing or new construction of on-site or off-site renewable energy based boilers;
H6. Any other source such as district heat; and
H7. Other heat generation technologies (e.g. heat pumps or solar energy).

Other renewable sources can not be considered alternatives to the project activity since they are not applicable to the project site and there is a lack of renewable energy source in the area. Options H3, H5, H6 and H7 are not credible alternatives to the project activity and will be not further considered.

Landfills are usually constructed in territory far away from the downtown in order to minimize the environmental impacts in local population. Shenyang Laohuchong landfill is about 28 km from the nearest potential consumer of a scale big enough to meet the project supply. It is not feasible to invest on a biogas distribution network to transport the biogas generated at the landfill site for a distance of 28 km. Alternative H1 can not be considered an alternative to the project activity.

Sub-step 1b. Enforcement of applicable laws and regulations.
According to Chinese regulations, coal fired power plants of less than 135MW[7] are prohibited for construction in the areas covered by the large grids such as provincial grids. Moreover, the construction of thermal units under 100MW is strictly limited[8]. Alternative H2 is not in compliance with China's relevant laws and regulations so cannot be considered a realistic and credible alternative to the project activity.

[7] Notice of the General Office of the State Council concerning the Strict Prohibition of the Construction of Thermal Power Units with a Capacity of 135MW or below, issues by the General Office of the State Council, Guo Ban Fa Ming Dian [2002] Document No.6.
[8] Prescribe on construction and supervise of the small scale thermal power generation units, August 1997. Chinese new energy website http://www.newenergy.org.cn/html/2006-2/2006217_7650.html.

Step 4. Common Practice Analysis.

Sub-step 4a. Analyze other activities similar to the proposed activity
According to the "Nation Urban Solid Waste Landfill Harmless Treatment Checking Bulletin" issued by Construction Department of China, up to the end of 2005, there are altogether 372 landfills in 661 cities national wide. Among them only 27 landfills installed LFG utilization system, which accounts for 7.24% of the total amount. More than 90% of LFG is recovered.

Besides, according to the *National Action Plan for Recovery and Utilization of Landfill Gas* published in December 2001, as part of study conducted by the UNDP/GEF and the China State Environmental Protection Authority, at present in China the municipal refuse is disposed using the technology of traditional landfill, without consideration of recovery and utilization of landfill gas.

There are three projects comparable to the project activity that were not carry out as CDM projects in China which are the Anshan, Nanjing, and Ma'anshan projects. Even thought, they were supported by the "Global Environment Fund (GEF)" (international fund) and developed under the "Accelerate Urban Waste LFG Collection and Utilization" Project Progress.
The passive venting method remains the common practice in current landfill situation in China.
Given the limited experience with landfill gas recovery and utilisation in China, the CDM is being promoted as a financing tool to enable these projects to go forward.

Sub-step 4b. Discuss any similar options that are occurring.
Landfill gas recovery and utilisation in China for power cannot be considered common practice because there are so few in operation and those that are in operation have been grant financed through the GEF or through the CDM procedure.

Summary
To conclude, it was proved that the proposed project activity is not the baseline scenario.
The only possible alternative to the project activity is carrying it out without being registered as CDM project activity.
The investment analysis provides essential evidence that the CDM revenue enables the proposed project to be developed in China. However, without any support from CDM the proposed project activity would not occur, instead the landfill operator would continue the current prevailing practice of not flaring or generating electricity from LFG.
Based on the above analysis, it can be demonstrated that the proposed project is additional.

B.6. Emission reductions:

B.6.1. Explanation of methodological choices:

For predicting the amount of CERs, the Approved Consolidated Methodology ACM0001 and ACM0002 have been used. A description of the used methodologies follows hereafter.

Calculation of GHG emission reductions

The greenhouse gas emission reduction achieved by the project activity during a given year "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.

Determination of $MD_{reg,y}$

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

Where:

$MD_{reg,y}$ = Methane that would be destroyed in the baseline in year y (tCH_4/y)
$MD_{project,y}$ = Methane destroyed by the project activity in year y (tCH_4/y)
AF = Adjustment Factor (%)

Determination of $MD_{project,y}$

According to ACM001, $MD_{project,y}$ will be determined *ex-post* by measuring the actual quantity of methane captured and destroyed once the project activity is operational.
The methane destroyed by the project activity ($MD_{project,y}$) during a year is determined by monitoring the quantity of methane actually flared and gas used to generate electrical or thermal energy.

The applicable ACM0001 formula therefore will be:

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

The quantity of methane destroyed by flaring is calculated using the following equation:

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

Where:

$MD_{flare,y}$ = Quantity of methane destroyed by flaring (tCH_4/y)
$LFG_{flare,y}$ = Quantity of landfill gas flared during the year (Nm^3LFG/y)
$W_{CH4,y}$ = Average methane fraction of the landfill gas as measured during the year (m^3CH_4/m^3LFG)
D_{CH4} = Density of methane (tCH_4/m^3CH_4)
$PE_{flare,y}$ = Project emissions from flaring of the residual gas stream (tCO_2/y)
GWP_{CH4} = Global Warming Potential of methane valid for the commitment period (tCO_{2e}/tCH_4)

The quantity of methane destroyed by generation of electricity is:

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

Where:

$MD_{electricity,y}$ = Quantity of methane destroyed by generation of electricity (tCH_4/y)
$LFG_{electricity,y}$ = Quantity of landfill gas fed into electricity generator (Nm^3LFG/y)
$W_{CH4,y}$ = Average methane fraction of the landfill gas measured during the year (m^3CH_4/m^3LFG)
D_{CH4} = Density of methane (tCH_4/Nm^3CH_4)

Calculation of the emission factor of the North East China Electric Power Grid

The calculation of the emission factor from the power grid of the proposed project was based on the instruction of ACM0002. All the data employed in the calculation has been taken from the available data from North East China Electric Power Grid. The baseline emission factor (EF_y) is calculated as a combined margin, consisting of the combination of operating margin (OM) and build margin (BM) factors.
The EF_y is calculated through the following three steps:

Step 1. Calculation of the Operating Margin emission factor ($EF_{OM,y}$) based on one of the four following methods:

a) Simple OM, or
b) Simple adjusted OM, or
c) Dispatch Data Analysis OM, or
d) Average OM.

If dispatch data of the grid is available (dispatch sequence of grid system, hourly electricity volume dispatched among all power plants), dispatch data analysis should be the first methodological choice. When dispatch data analysis is not applicable, (a) simple OM, or (b) simple adjusted OM, or (d) average OM may be used taking into account the previsions outlined hereafter :

The Simple OM method (a) can only be used where low-cost/must run resources constitute less than 50% of total grid generation in: 1) average of the five most recent years, or 2) based on long-term normals for hydroelectricity production.

Simple Adjusted OM (b) is a variation on Simple OM method, where the power sources (including imports) are separated in low-cost/must-run power sources (k) and other power sources (j). The Load Duration Curve is required for applying this method.

The average emission rate method (d) can only be used where low-cost/must run resources constitute more than 50% of total grid generation and detailed data to apply option (b) is not available, and where detailed data to apply option (c) above is unavailable.

The emission factor of simple OM, simple adjusted OM and average OM can be calculated using either one of the following two data vintages for years:

Option 1 (ex-ante): A 3-year average, based on the most recent statistics available at the time of PDD submission, or
Option 2: The year in which project generation occurs, if emission factor is updated based on *ex-post* monitoring.

The Simple OM (a) instead of method (b), (c), or (d) was selected for the project activity for the following three reasons:

- Currently the State Grid conducts electricity dispatch across regional grids. The grid dispatch data and the load curves are the business secrets, which are not publicly available. Then option (b) and (c) are not applicable.
- According to the data from China Electric Power Yearbook 2006, fuel fired power plants accounted for 91.31% of the total capacity additions in North East Power Grid during 1998-2005. All in all, the Northeast Power system is dominated by coal fired power, which will not change for a long time. Therefore, option (d) is not applicable.
- Low-cost/must-run resources account for less than 50% of total amount of grid power generation so Simple OM is applicable.

Besides, a 3-year average based on the most recent statistics available at the time of PDD submission was used to *ex-ante* calculate operating margin (OM) emission factor in this PDD.

The Simple OM emission factor ($EF_{OM,simple,y}$) is calculated as the generation weighted average emissions per electricity unit (tCO_2/MWh) of all generating sources serving the system, not including low-operating cost and must-run power plants.

$$EF_{OM,simple,y} = \frac{\sum_{i,j} F_{i,j,y} \cdot COEF_{i,j}}{\sum_{j} GEN_{j,y}}$$

Where:

$F_{i,j,y}$ = Amount of fuel *i* (in a mass or volume unit) consumed by province *j* in year(s) *y*,
$COEF_{i,j\,y}$ = CO_2 emission coefficient of fuel *i* (tCO_2 / mass or volume unit of the fuel), taking into account the carbon content of the fuels used by province *j* and the percent oxidation of the fuel in year(s) *y*,
$GEN_{j,y}$ = Electricity (MWh) delivered to the grid by province *j* in year(s) *y*.

In "China Electric Yearbook" and from the other data sources, the only available data is electricity generated, that can be converted into electricity delivered to the grid using the following formulae:

$$GEN_{j,y} = G_{j,y} \times \left(1 - \eta_{j,y}\right)$$

Where:

$G_{j,y}$ = Electricity generated (MWh) by province *j* in year *y*,
$\eta_{j,y}$ = Electricity self-consumption rate of sources in province *j* in year *y*,

The CO_2 emission coefficient $COEF_i$ is obtained as:

$$COEF_i = NCV_i \cdot EF_{CO2,i} \cdot OXID_i$$

Where:
NCV_i = Net calorific value (energy content) per mass or volume unit of a fuel *i*, which is country-specific value defined by Chinese government.
$OXID_i$ = Oxidation factor of the fuel, which is IPCC world-wide default values.
$EF_{CO2,i}$ = CO_2 emission factor per unit of energy of the fuel *i*, which is IPCC world-wide default values.

When a grid has a net incoming dispatch, if the dispatch comes from specific sources, the emission factor of the sources should be used; if the sources are not known, the average emission factor of source grid should be used.

The emission factors were calculated based on the data on electricity generation, auxiliary electricity consumption, different fuel consumptions for power generation and the net caloric values of the fuels obtained from the latest *China Electric Power Yearbook* . The emission factors and oxidation factors of the fuels adopted are obtained from the *IPCC Guidelines for National Greenhouse Gas Inventories: Workbook*.

The operating margin (OM) emission factors of North East Electric Power Grid is:

$EF_{OM,y}$= 1.2403 tCO_2/MWh.

STEP 2. Calculate the Build Margin emission factor ($EF_{BM,y}$) as the generation weighted average emission factor (tCO_2/MWh) of a sample of power plants m, as follows**:**

$$EF_{BM,y} = \frac{\sum_{i,m} F_{i,m,y} \cdot COEF_{i,m}}{\sum_{m} GEN_{m,y}}$$

Where:
$F_{i,m,y}$ = Amount of fuel *i* (tce, tons of coal equivalence) consumed by source m in year(s) *y*,
$COEF_{i,m\,y}$ = CO_2 emission coefficient of fuel *i* (tCO_2/tce), taking into account the carbon content of fuel *i* used by source m and the percent oxidation of the fuel in year(s) *y*,
$GEN_{m,y}$ = Electricity (MWh) delivered to the grid by source m in year(s) *y*.

According to the methodology project participants shall choose between one of the following two options for calculating the BM emission factor.

Option 1. Calculate the Build Margin emission factor $EF_{BM,y}$ *ex-ante* based on the most recent information available on plants already built for sample group m at the time of PDD submission.
The sample group *m* consists of either the five power plants that have been built most recently, or the power plants capacity additions in the electricity system that comprise 20% of the system generation (in MWh) and that have been built most recently.

Option 2. For the first crediting period, the Build Margin emission factor $EF_{BM,y}$ must be updated annually *ex-post* for the year in which actual project generation and associated emissions reductions occur.
For subsequent crediting periods, $EF_{BM,y}$ should be calculated *ex-ante*, as described in option 1 above. The sample group *m* consists of either the five power plants that have been built most recently, or the power plants capacity additions in the electricity system that comprise 20% of the system generation (in MWh) and that have been built most recently.

This PDD adopts Option 1 and calculates the Build Margin emission factor *ex-ante* following the alternative that approved by the Executive Board.

Since the information of the sample group *m* is not available in China, a CDM Executive Board approved alternative was adopted. According to the alternative, the generation capacity of and the proportions of different generating technologies used in the mostly recent capacity additions would be calculated at first. The weight of each generating technology used in the capacity additions can then be worked out, and finally the Build Margin emission factor would be calculated with the commercial optimal efficiencies of the generating technologies.

Owing to the fact that it is impossible to distinguish the proportions of different thermal power generation technologies, such as coal, fuel oil and gas, from currently available statistics, the Build Margin emission factor was calculated with the following method.
First, to calculate the proportions of CO_2 emission generated by solid fuel, liquid fuel, and gas fuel power plants based on the available data of Energy Balance Sheet in the most recent year; secondly, weighted by the proportions, to calculate the average value of the thermal power emission factors corresponding to the commercially optimal efficiencies; finally to multiply the average thermal power emission factor with the proportion of thermal power generation that comprise 20% of the capacity additions, the product is the Build Margin emission factor of the grid.

The detailed steps and formulae are listed below.

Step 1) Calculation of proportions of the CO_2 emission volume generated by solid fuel, liquid fuel, and gas fuel power plants in the total emission volume.

$$\lambda_{Coal} = \frac{\sum_{i \in COAL, j} F_{i,j,y} \times COEF_{i,j}}{\sum_{i,j} F_{i,j,y} \times COEF_{i,j}}$$

$$\lambda_{Oil} = \frac{\sum_{i \in OIL, j} F_{i,j,y} \times COEF_{i,j}}{\sum_{i,j} F_{i,j,y} \times COEF_{i,j}}$$

$$\lambda_{Gas} = \frac{\sum_{i \in GAS, j} F_{i,j,y} \times COEF_{i,j}}{\sum_{i,j} F_{i,j,y} \times COEF_{i,j}}$$

Where:

$F_{i,j,y}$ = Amount of fuel *i* (tce) consumed by province *j* in year(s) *y*,
$COEF_{i,j\,y}$ = CO_2 emission coefficient of fuel *i* (tCO_2/tce), taking into account the carbon content of the fuels used by province *j* and the percent oxidation of the fuel in year(s) *y*, COAL, OIL and GAS are the footnotes representing for solid, liquid and gas fuels respectively.

Step 2) Calculation of the emission factors of thermal power generation.

$$EF_{Thermal} = \lambda_{Coal} \times EF_{Coal,Adv} + \lambda_{Oil} \times EF_{Oil,Adv} + \lambda_{Gas} \times EF_{Gas,Adv}$$

Where:

$EF_{Coal,Adv}$, $EF_{Oil,Adv}$ and $EF_{Gas,Adv}$ are the emission factors corresponding to coal, fuel oil and gas generation technologies under commercially optimal efficiency. Refer to Annex 3 for the detailed parameters.

Step 3) Calculation of the BM emission factor of the grid

$$EF_{BM,y} = \frac{CAP_{Thermal}}{CAP_{Total}} \times EF_{Thermal}$$

Where:

CAP_{Total} = Total capacity additions,
$CAP_{Thermal}$ = Thermal capacity additions.

The Build Margin emission factor of North East Electric Power Grid is:

$EF_{BM,y}$= 0.8632 tCO_2/MWh

Step 3. Calculation of the baseline emission factor EF_y, i.e. the weighted average value of operating margin ($EF_{OM,y}$) and build margin ($EF_{BM,y}$) :

$$EF_y = w_{OM} \cdot EF_{OM,y} + w_{BM} \cdot EF_{BM,y}$$

Where:

The default value of weight w_{OM} and w_{BM} are 50% (i.e. $w_{OM} = w_{BM} = 0.5$).

The Emission Factor of the North East Electric Power Grid is:

$EF_y = CEF_{elec} = 1.05176\ tCO_2/MWh$

Calculation of the project emissions from flaring

The "*tool to determine project emissions from flaring gases containing methane*" should be applied in order to calculate the project emissions from flaring of a residual gas stream (RG) in landfills.

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

Where:

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

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

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

Where:

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

Leakage calculation

No leakage effects need to be accounted under ACM0001 methodology.

B.6.2. Data and parameters that are available at validation:

Data / Parameter:	L_0
Data unit:	Nm^3CH_4 / Mg of waste
Description:	Potential CH_4 generation capacity
Source of data used:	
Value applied:	*116*
Justification of the choice of data or description of measurement methods and procedures actually applied :	L_0 is a constant that represents the potential capacity of a landfill to generate CH_4 (a primary constituent of landfill gas). L_0 depends on the amount of cellulose in the waste. L_0 was calculated taken into account China's waste type and using formula attached in Annex 3.
Any comment:	

Data / Parameter:	k
Data unit:	$year^{-1}$
Description:	Rate of methane generation
Source of data used:	
Value applied:	*0.0668*
Justification of the choice of data or description of measurement methods and procedures actually applied :	k is a constant that determines the rate of landfill gas generation. The first-order decomposition rate assumes that k values before and after peak landfill gas generation are the same. k is a function of moisture content in the landfill waste, availability of nutrients for methanogens, pH, and temperature. k was calculated taken into account China's rainfall and using formula attached in Annex 3.
Any comment:	

Data / Parameter:	GWP_{CH4}
Data unit:	tCO_{2e}/tCH_4
Description:	Global Warming Potential value for methane
Source of data used:	IPCC Guideline for National Greenhouse Gas Inventory
Value applied:	*21*
Justification of the choice of data or description of measurement methods and procedures actually applied :	
Any comment:	

Data / Parameter:	$\rho_{CH4,n,h}$
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 applied:	*0.0007168*
Justification of the choice of data or description of measurement methods and procedures actually applied :	Parameter defined within the tool, "*tool to determine project emissions from flaring gases containing methane*"
Any comment:	

Data/Parameters	NCV_i
Data unit:	MJ/t, or MJ/Km^{3}t
Description:	Net calorific value per mass or volume unit of a fuel *i*
Source of data used:	*China Energy Statistical Yearbook*
Value applied:	*Please refer to Annex 3*
Justification of the choice of data or description of measurement methods and procedures actually applied :	Official released statistic; publicly accessible and reliable data source
Any comment:	*Official data*

Data/Parameters	$OXID_i$
Data unit:	
Description:	Oxidation factor of the fuel *i*
Source of data used:	*IPCC 2006*
Value applied:	*Please refer to Annex 3*
Justification of the choice of data or description of measurement methods and procedures actually applied :	According to the latest version of ACM0002, the proposed project should use the IPCC default values
Any comment:	*IPCC data*

Data/Parameters	$EF_{CO2,i}$
Data unit:	tC/TJ
Description:	CO_2 emission factor per unit of energy of the fuel *i*
Source of data used:	*IPCC 2006*
Value applied:	*Please refer to Annex 3*
Justification of the choice of data or description of measurement methods and procedures actually applied :	According to the latest version of ACM0002, the proposed project should use the IPCC default values
Any comment:	*IPCC data*

Data/Parameters	$F_{i,j,y}$
Data unit:	10^4t or 10^6 m^3
Description:	Amount of fuel *i* (in a mass or volume unit) consumed by province j in year(s) y
Source of data used:	*China Energy Statistical Yearbook*
Value applied:	*Based on http://cdm.ccchina.gov.cn and detailed in Annex 3*
Justification of the choice of data or description of measurement methods and procedures actually applied :	Official released statistic; publicly accessible and reliable data source
Any comment:	*Official data*

Data/Parameters	$G_{j,y}$
Data unit:	MWh
Description:	Electricity (MWh) generation by province *j* in year *y*
Source of data used:	*China Electric Power Yearbook*
Value applied:	*Please refer to Annex 3*
Justification of the choice of data or description of measurement methods and procedures actually applied :	Official released statistic; publicly accessible and reliable data source
Any comment:	*Official data*

Data/Parameters	$\eta_{j,y}$
Data unit:	%
Description:	Rate of electricity self-consumption by sources in province *j* in year *y*
Source of data used:	*China Electric Power Yearbook*
Value applied:	*Please refer to Annex 3*
Justification of the choice of data or description of measurement methods and procedures actually applied :	Official released statistic; publicly accessible and reliable data source
Any comment:	*Official data*

Data/Parameters	$CAP_{y,j}$
Data unit:	MW
Description:	The installed capacity of every kind of electricity generation (such as thermal power, hydro power, nuclear power, wind power and other energy sources etc.) of the North East Electric Power Grid in the recent years
Source of data used:	*China Electric Power Yearbook*
Value applied:	*Please refer to Annex 3*
Justification of the choice of data or description of measurement methods and procedures actually applied :	Official released statistic; publicly accessible and reliable data source
Any comment:	*Official data*

B.6.3. Ex-ante calculation of emission reductions:

Following the instructions outlined in the Baseline Methodology (ACM0001), *ex-ante* emission reductions estimated for methane extraction and destruction are projected for reference purposes only. The project activity, once commissioned, will determine emission reductions on an *ex-post* basis by measuring project data as stipulated in the monitoring plan. This data will be used to calculate emission reductions for the project activity.

To calculate *ex-ante* the GHG emissions of the landfill the LandGEM 3.02[9] model is used. The model allows to calculate the amount of methane generated from the landfill.

LandGEM uses the first-order decomposition rate equation shown below, to estimate the annual emission of methane over a specified period of time:

$$Q_{CH_4} = \sum_{i=1}^{n} \sum_{j=0.1}^{1} kL_0 \left(\frac{M_i}{10} \right) e^{-kt_{ij}}$$

Where:

Q_{CH4} = Annual methane generation in the year of the calculation (Nm^3 CH_4/y)
i = 1-year time increment
n = Year of the calculation (initial year of waste acceptance)
j = 0.1 year time increment
k = Methane generation rate ($year^{-1}$)
L_0 = Potential methane generation capacity (Nm^3 CH_4/Mg of waste)
M_i = Mass of waste accepted in the i^{th} year (Mg of waste/y)
t_{ij} = Age of the j^{th} section of waste mass M_i accepted in the i^{th} year (decimal years)

The methane generated in the landfill, extracted and used for energy production is calculated using the following formula:

$$Q_{cCH4,y} = CE * Q_{CH4,y} * BWH / 8,760$$

Where:

$Q_{cCH4,y}$ = Annual methane extracted in the year of the calculation (Nm^3CH_4/y)
CE = Biogas Capture Efficiency (%)
$Q_{CH4,y}$ = Annual methane generation in the year of the calculation (Nm^3CH_4/y)
BWH = Working hours of blowers (h/y)

Tab. B. 5: Annual methane extracted for each year

[9] LandGEM is an emissions estimation tool developed and distributed by EPA to estimate emission rates for methane (and other pollutants) from landfills. LandGEM is based on a first order decay equation. The model can be run using site-specific data or default values, if site-specific data is not available.

Year	Annual methane extracted ($Q_{cCH4,y}$) [Nm^3CH_4/y]
2009	5,156,991
2010	5,862,558
2011	6,522,532
2012	7,139,861
2013	7,717,299
2014	8,257,424
2015	8,762,647
2016	9,235,224
2017	9,677,265
2018	10,090,741

The LFG captured is calculated *ex-ante* using the amount of methane extracted obtained with the LandGEM model as follow:

$$LFG_{captured} = Q_{cCH4,y} / (W_{CH4,y} * 8,760)$$

Where:

$LFG_{captured}$ = Landfill gas captured (Nm^3/h)
$Q_{cCH4,y}$ = Annual methane extracted in the year of the calculation (Nm^3CH_4/y)
$W_{CH4,y}$ =Average methane fraction of the landfill gas as measured during the year (m^3CH_4/m^3LFG)

The greenhouse gas emission reduction achieved by the project activity during a given year "y" (ER_y) is calculated by using the formulas as given in methodology 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*.

The project will not consume or produce thermal energy ($ET_{LFG,y}$ and $ET_{PR,y} = 0$),

Determination of EL_y

When needed, electricity from the power grid will be imported in order to meet the project requirements. In this situation $CEF_{elec,B,y}$ and $CEF_{elec,PR,y}$ are the same and the net amount of electricity exported to the grid is:

$$EL_y = EL_{LFG,y} - EL_{PR,y}$$

Where:

EL_y = Net quantity of electrical energy exported during the year (MWh/y)

$EL_{LFG,y}$ = 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/Y)

$EL_{PR,y}$ = 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/y)

The electricity consumed by the project activity is calculated *ex-ante* as a percentage of the electricity generated. Once the plant becomes operational, the electricity supply and consumed from the grid will be measure as stated is the monitoring plan.

$$EL_{PR,y} = AC\% * EL_{LFG,y}$$

$EL_{PR,y}$ = Amount of electricity imported from the grid as a result of project activity (MWh/y)

$AC\%$ = Percentage of electrical energy used for the biogas plant auto-consumptions (%)

$EL_{LFG,y}$ = Net quantity of electricity produced using landfill gas during year y, (MWh/y)

The electricity produced by the project activity is calculated as follow:

$EL_{PR,Theoric} = Q_{cCH4,y} * HV_{CH4} * GER / (ECF * 1,000 * BWH)$

Where:

$EL_{PR,Theoric}$ = Theoric capacity installed, in megawatt (MW)
$Q_{cCH4,y}$ = Annual methane extracted in the year of the calculation (Nm^3CH_4/y)
HV_{CH4} = Methane heating value ($kCal/Nm^3CH_4$)
GER = Generator Efficiency Rate (%)
ECF = Energy conversion factor (kCal/kWh)
BWH = Working hours of blowers (h/y)

The effective MW is calculated considering the engine working hours (EWH) and the theoric capacity installed ($EL_{PR\ Theoric}$) obtained with the formula above, Since the quantity of LFG is supposed to be incremented during the entire crediting period, the 3 MW will be installed successively in numerous phases according to the LFG generation rate the phases are forecasted as follow:.

1st phase 2007 - 2008

The construction of Biogas collection section started on the July of 2007. 48 new wells were drilled with depth variable between 12 and 21 meter by waste disposal operations. Because during the drilling operation we have seen a high level of the leachate in the landfill a system for the leachate capture has been mounted made by 29 pumps.

The construction of Biogas conveying section started in August 2007 and ended in September 2007. We have installed 4 substations of regulation, 4,000 meters of secondary pipeline (HDPE SDR 17,6 DN90) and 2,500 meters of primary pipeline (HDPE SDR 17,6 DN160)

The suction, treatment, analysis section and the electric energy generation section started on July and ended on October.

On August started the installation of suction station apparatus and of the monitoring system. On the 24th of August was installed the torch.
Biogas flaring plant officially started up On the 18th of October 2007.

The construction of electric energy generation, transformation and distribution section started on September, 2007 with the installation of 3 engines made in China, type G12V190ZLDZ-2 of 500kW. The high voltage connection (20.000 Volts) started in October 2007 and finished on February 2008.

2nd phase – year 2009 - 2010

In this period we forecast the installation of the 4th engine made in China, type G12V190ZLDZ-2 of 500kW.

3rd phase – year 2011 - 2012

We forecast to drill 77 new wells with depth around 13 meters
We forecast to install 7 substation of regulation, 5,565 meters of secondary pipeline (HDPE SDR 17,6 DN90) and 2900 meters of primary pipeline (HDPE SDR 17,6 DN160)
We forecast to update the biogas suction, treatment, analysis and flare combustion section with the installation a chiller, a heat exchanger, two blowers.

In this period we forecast the installation of 5th engines made in China, type G12V190ZLDZ-2 of 500kW.

4th phase – year 2014-2015

In this period we forecast the installation of 6th engines made in China, type G12V190ZLDZ-2 of 500kW.

Other activities will be planned and implemented based on the operation conditions in order to guarantee the best performance of the plant.

Afterwards, it is estimated the net quantity of electricity produced ($EL_{PR,y}$)

Tab. B. 6: The electricity produced ($EL_{LFG,y}$) by the project activity is reported in the following table:

Year	Theoric MW	Effective MW installed	Net quantity of electricity produced ($EL_{LFG,y}$) [MWh/y]
2009	1.746	1.5	12,000
2010	1.985	2	15,879
2011	2.208	2	16,000
2012	2.417	2.5	19,339
2013	2.613	2.5	20,000
2014	2.796	2.5	20,000
2015	2.967	3	23,735
2016	3.127	3	24,000
2017	3.277	3	24,000
2018	3.416	3	24,000

The quantity of electrical energy that will be supply to the power grid by the project activity is:

Tab. B. 7: Net quantity of electrical energy exported during the year

Year	**Net quantity of electricity produced ($EL_{LFG,y}$) [MWh/y]**	**Amount of electricity imported ($EL_{PR,y}$) [MWh/y]**	**Net quantity of electrical energy exported during the year (EL_y) [MWh/y]**
2009	12,000	576	11,424
2010	15,879	762	15,117
2011	16,000	768	15,232
2012	19,339	928	18,411
2013	20,000	960	19,040
2014	20,000	960	19,040
2015	23,735	1,139	22,595
2016	24,000	1,152	22,848
2017	24,000	1,152	22,848
2018	24,000	1,152	22,848

Determination of $MD_{reg,y}$

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

Where:

$MD_{reg,y}$ = Methane that would be destroyed in the baseline in year y (tCH_4/y)
$MD_{project,y}$ = Methane destroyed by the project activity in year y (tCH_4/y)
AF = Adjustment Factor (%)

Since there are no regulatory or contractual requirements that obligate to install a specific system for collection and destruction of methane or to collect and destroy a specific percentage of the “generated” amount of biogas, the Adjustment Factor is considered zero.

Determination of $MD_{project,y}$

According to ACM0001, $MD_{project,y}$ will be determined *ex-post* by metering the actual quantity of methane captured and destroyed once the project activity is operational.
The methane destroyed by the project activity ($MD_{project,y}$) during a year is determined by monitoring the quantity of methane actually flared and the quantity of gas used to generate electricity.

Within this project there are no intentions to produce thermal energy ($MD_{thermal,y} = 0$)

The applicable ACM0001 formula therefore will be:

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

The quantity of methane destroyed by flaring is calculated using the following equation:

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

Where:

$MD_{flare,y}$ = Quantity of methane destroyed by flaring (tCH_4/y)
$LFG_{flare,y}$ = Quantity of landfill gas flared during the year measured in (Nm^3LFG/y)
$W_{CH4,y}$ =Average methane fraction of the landfill gas as measured during the year (m^3CH_4/m^3LFG)
D_{CH4} = Density of methane (tCH_4/Nm^3CH_4)
$PE_{flare,y}$ = Project emissions from flaring of the residual gas stream (tCO_2/y)
GWP_{CH4} = Global Warming Potential of methane valid for the commitment period (tCO_{2e}/tCH_4)

The project proposed will adopt 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*" and the manufactures' specifications,
When the project becomes operational the flare efficiency in the hour h ($\eta_{flare,h}$) will be considered according to the following approaches:

- 0% if the temperature in the exhaust gas of the flare (T_{flare}) is below 500°C for more than 20 minutes during the hour h ,
- 50%, if the temperature in the exhaust gas of the flare (T_{flare}) is above 500°C 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,
- 90%, if the temperature in the exhaust gas of the flare (T_{flare}) is above 500°C 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.

The quantity of methane destroyed by generation of electricity is calculated using the following equation:

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

Where:

$MD_{electricity,y}$ = Quantity of methane destroyed by generation of electricity (tCH_4/y)
$LFG_{electricity,y}$ = Quantity of landfill gas fed into electricity generator (Nm^3LFG/y)
$W_{CH4,y}$ =Average methane fraction of the landfill gas measured during the year (m^3CH_4/m^3LFG)
D_{CH4} = Density of methane (tCH_4/Nm^3CH_4)

Tab. B. 8: Total landfill gas

Year	Quantity of landfill gas flared ($LFG_{flare,y}$) [Nm^3LFG/y]	Quantity of landfill gas fed into electricity generator ($LFG_{electricity,y}$) [Nm^3LFG/y]	Total quantity of landfill gas ($LFG_{total,y}$) [Nm^3LFG/y]
2009	1,974,589	8,339,394	10,313,983
2010	689,713	11,035,403	11,725,116
2011	1,925,872	11,119,192	13,045,064
2012	839,984	13,439,737	14,279,721
2013	1,535,607	13,898,990	15,434,597
2014	2,615,858	13,898,990	16,514,847
2015	1,030,900	16,494,395	17,525,295
2016	1,791,661	16,678,788	18,470,449
2017	2,675,742	16,678,788	19,354,530
2018	3,502,695	16,678,788	20,181,483

Tab. B. 9: Methane destroyed by the project activity ($MD_{project}$)

Year	Methane destroyed by the project activity ($MD_{project,y}$) [tCH_4/y]
2009	3,626
2010	4,178
2011	4,606
2012	5,088
2013	5,477
2014	5,825
2015	6,244
2016	6,556
2017	6,841
2018	7,108

B.6.4. Summary of the ex-ante estimation of emission reductions:

Tab. B. 10: Total emission reductions

Year	Estimation of baseline emissions (tCO2e)	Estimation of project activity emissions (tCO2e)	Estimation of Leakage (tCO2e)	Estimation of overall emission reductions (tCO2e)
2009	88,156	0	0	**88,156**
2010	103,628	0	0	**103,628**
2011	112,753	0	0	**112,753**
2012	126,207	0	0	**126,207**
2013	135,037	0	0	**135,037**
2014	142,354	0	0	**142,354**
2015	154,891	0	0	**154,891**
2016	161,698	0	0	**161,698**
2017	167,687	0	0	**167,687**
2018	173,288	0	0	**173,288**
Total (t CO_{2e})	**1,365,700**	**0**	**0**	**1,365,700**

B.7. Application of the monitoring methodology and description of the monitoring plan:

B.7.1. Data and parameters monitored:

The monitoring methodology is based on direct measurement of the amount of landfill gas captured and destroyed by flaring and used in the engines in order to generate electricity for the North East Electric Power Grid.

Data / Parameter:	$LFG_{total,y}$
Data unit:	Nm^3
Description:	Total amount of landfill gas captured
Source of data to be used:	*Flow meter*
Value of data applied for the purpose of calculating expected emission reductions in section B.5	*The parameter is calculated ex-ante using LandGEM model, and the value for each year is shown in section B.*
Description of measurement methods and procedures to be applied:	Measured by a flow meter, normalized according to landfill gas temperature and pressure. This unit will measure directly Nm^3 of LFG being delivered to the plant. The flow will be measured continuously and data will be aggregated hourly, monthly and yearly.
QA/QC procedures to be applied:	*Data with low level of uncertainty. QA/QC procedures are planned for these data. Flow meters should be subject to regular maintenance and testing regime to ensure accuracy.*
Any comment:	*Data will be archived electronically during the crediting period and two years after.*

Data / Parameter:	$LFG_{flare,y}$
Data unit:	Nm^3
Description:	Amount of landfill gas flared
Source of data to be used:	*Flow meter*
Value of data applied for the purpose of calculating expected emission reductions in section B.5	*The parameter is calculated as shown in section B.*
Description of measurement methods and procedures to be applied:	Measured by a flow meter, normalized according to landfill gas temperature and pressure. This unit will measure directly Nm^3 of LFG being delivered to the flare. The flow will be measured continuously and data will be aggregated hourly, monthly and yearly.
QA/QC procedures to be applied:	*Data with low level of uncertainty. QA/QC procedures are planned for these data. Flow meters should be subject to regular maintenance and testing regime to ensure accuracy.*
Any comment:	*Data will be continuously recorded and archived electronically during the crediting period and two years after.*

Data / Parameter:	$LFG_{electricity,y}$
Data unit:	Nm^3
Description:	Amount of landfill gas combusted in power plant
Source of data to be used:	*Flow meter*
Value of data applied for the purpose of calculating expected emission reductions in section B.5	*The parameter is calculated as shown in section B.*
Description of measurement methods and procedures to be applied:	Measured by a flow meter, normalized according to landfill gas temperature and pressure, this unit will measure directly Nm^3 of LFG being delivered to the engines. The flow will be measured continuously, and data will be aggregated hourly, monthly and yearly.
QA/QC procedures to be applied:	*Data with low level of uncertainty. QA/QC procedures are planned for these data. Flow meters should be subject to regular maintenance and testing regime to ensure accuracy.*
Any comment:	*Data will be recorded continuously and archived electronically during the crediting period and two years after.*

Data / Parameter:	$W_{CH4,y}$
Data unit:	m^3CH_4/ m^3LFG
Description:	Methane fraction in the landfill gas
Source of data to be used:	*Gas Analyser*
Value of data applied for the purpose of calculating expected emission reductions in section B.,5	*50% (see Annex 3)*
Description of measurement methods and procedures to be applied:	Measure continuously with a gas analyser on wet basis, and aggregated hourly, monthly and yearly.
QA/QC procedures to be applied:	*Data with low level of uncertainty. QA/QC procedures are planned for these data. The gas analyzer is subject to regular maintenance and testing regime to ensure accuracy.*
Any comment:	*Data will be continuously recorded and archived electronically during the crediting period and two years after.*

Data / Parameter:	EL_{LFG}
Data unit:	MWh
Description:	Net amount of electricity generated using landfill gas
Source of data to be used:	*Electricity meter*
Value of data applied for the purpose of calculating expected emission reductions in section B.5	*The value calculated for each year is shown in section B.,*
Description of measurement methods and procedures to be applied:	Required to estimate the emission reductions from electricity generation from LFG. Data will be measured continuously with an electricity meter and will be aggregated monthly and yearly through measurement device
QA/QC procedures to be applied:	*Electricity meter will be maintained and calibrated regularly to ensure the accuracy of the measurement instrument.*
Any comment:	*Data will be continuously recorded and archived electronically during the crediting period and two years after.*

Data / Parameter:	EL_{PR}
Data unit:	MWh
Description:	Total amount of electricity required to meet the project requirement
Source of data to be used:	*Electricity meter*
Value of data applied for the purpose of calculating expected emission reductions in section B.5	*The value calculated for each year is shown in section B.*
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. Data will be measured continuously with an electricity meter and aggregated hourly, monthly and yearly through measurement device.
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.*
Any comment:	*Data will be continuously recorded and archived electronically during the crediting period and two years after.*

Data / Parameter:	EWH
Data unit:	Hours
Description:	Engine working hours of power plant
Source of data to be used:	*Hour Meter*
Value of data applied for the purpose of calculating expected emission reductions in section B.5	*8,000*
Description of measurement methods and procedures to be applied:	This is monitored to ensure methane destruction is claimed for methane used in electricity plant when it is operational.
QA/QC procedures to be applied:	*Equipment will be maintained in line with manufacturer's recommendations to assure high quality output.*
Any comment:	*Data will be annually recorded and archived electronically during the crediting period and two years after.*

Data / Parameter:	Flare working hours
Data unit:	Hours
Description:	
Source of data to be used:	*Hour Meter*
Value of data applied for the purpose of calculating expected emission reductions in section B.5	*8,500*
Description of measurement methods and procedures to be applied:	This is monitored to ensure methane destruction. Is claimed for methane destruction by flaring when the flare is operational.
QA/QC procedures to be applied:	*Equipment will be maintained in line with manufacturer's recommendations to assure high quality output.*
Any comment:	*Data will be annually recorded and archived electronically during the crediting period and two years after.*

Data / Parameter:	$PE_{flare,y}$
Data unit:	tCO_2
Description:	Project emissions from flaring of the residual gas stream in year *y*
Source of data to be used:	*Measured and calculated*
Value of data applied for the purpose of calculating expected emission reductions in section B.5	*1,398* *(an annual average value during the crediting period)*
Description of measurement methods and procedures to be applied:	The parameters should be monitored as per the "*Tool to determine project emissions from flaring gases containing methane*"
QA/QC procedures to be applied:	
Any comment:	*Referring to the "Tool to determine project emissions from flaring gases containing methane"*

Data / Parameter:	$fv_{CH4,RG,h}$
Data unit:	-
Description:	volumetric fraction of methane in the residual gas on dry basis in hour *h*
Source of data to be used:	*Continuous gas analyser*
Value of data applied for the purpose of calculating expected emission reductions in section B.5	*50 %*
Description of measurement methods and procedures to be applied:	Measure on the same basis (dry or wet) that the measurement of the volumetric flow rate of the residual gas ($FV_{RG,h}$) when the residual gas temperature exceeds 60 ºC. Cyclically samples will be collected and used to calculate the averaged hourly value.
QA/QC procedures to be applied:	*Analysers will be calibrated according to the manufacturer's recommendation. A zero check and a typical value check will be performed by comparison with a standard certified gas.*
Any comment:	*As a simplified approach, it will be only measured the methane content of the residual gas and consider the remaining part as N_2. Besides, the gas entering the flare is absolutely the same as the one measured in the landfill gas, so the measured methane volumetric fraction data of landfill gas ($w_{CH4,y}$) will be used as volumetric methane fraction of residual gas. Data will be archived electronically during the crediting period and two years after.*

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*
Source of data to be used:	*Flow meter*
Value of data applied for the purpose of calculating expected emission reductions in section B.5	
Description of measurement methods and procedures to be applied:	Measure on the same basis (dry or wet) that the measurement of the volumetric fraction of the methane in the residual gas ($fv_{CH4,,h}$) when the residual gas temperature exceeds 60 ºC. Monitoring frequency is continuous, The values will be averaged hourly.
QA/QC procedures to be applied:	*Flow meters will be periodically calibrated according to the manufacturer's recommendation.*
Any comment:	*Data will be archived electronically during the crediting period and two years after.*

Data / Parameter:	T_{flare}
Data unit:	◦ C
Description:	Temperature in the exhaust gas of the enclosed flare
Source of data to be used:	*Thermocouple*
Value of data applied for the purpose of calculating expected emission reductions in section B.5	*Above 500 ◦ C according to manufactures' specifications.*
Description of measurement methods and procedures to be applied:	The temperature of the exhaust gas stream in the flare will be measure by a thermocouple in a continuous basis. A temperature above 500◦C indicates that a significant amount of gases are still being burnt and the flare is operating.
QA/QC procedures to be applied:	*Thermocouples will be calibrated every year according to the manufacturer's recommendation to ensure accuracy, or, if needed, replaced.*
Any comment:	*Data will be annually recorded and archived electronically during the crediting period and two years after.*

Data / Parameter:	Other flare operation parameters
Data unit:	-
Description:	Manufacturer's specification of the flare,
Source of data to be used:	*Measured on-site by the project participants*
Value of data applied for the purpose of calculating expected emission reductions in section B.5	
Description of measurement methods and procedures to be applied:	Continuously monitored.
QA/QC procedures to be applied:	*The operating conditions of the flare will be monitored according to the manufacturer's specification.*
Any comment:	*Data and parameters required to be monitored by the manufacturer will be measured to see if they meet the manufacturer's requirements.*

B.7.2. Description of the monitoring plan:

According to ACM0001, direct monitoring will be conducted on the LFG captured, destroyed by flare and used for power generation. The monitoring procedures will measure:

- Landfill gas flow collected from wells
- Landfill gas flow into flare,
- Landfill gas flow into engines
- Methane content in the landfill gas,
- Flare temperature.
- Emissions from flaring.
- Electricity imported from the power grid,
- Electricity exported to the power grid,
- Operation of the energy plant and flare
- Local and national regulatory framework.

The monitoring of the operation parameters during the operation of the plant will be carry out according to the monitoring plan on Annex 4.

B.8. Details of baseline information, including the date of completion of the baseline study and the name of person (s)/entity (ies) determining the baseline:

The baseline and monitoring study was completed on June 2008.

Person responsible for the application of the baseline and monitoring methodology to the project activity:

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Asja Ambiente Italia S.p.A. is a project participant,

SECTION C. Duration of the project activity / Crediting period

C.1. Duration of the project activity:

C.1.1. Starting date of the project activity:

01/07/2007 (starting day of construction)

C.1.2. Expected operational lifetime of the project activity:

15 years

C.2. Choice of the crediting period and related information:

C.2.1. Renewable crediting period:

C.2.1.1. Starting date of the first crediting period:

Not Applicable

C.2.1.2. Length of the first crediting period:

Not Applicable

C.2.2. Fixed crediting period:

C.2.2.1. Starting date:

01/01/2009

C.2.2.2. Length:

10 years

SECTION D. Environmental impacts

D.1.Documentation on the analysis of the environmental impacts, including transboundary impacts:

According to relevant laws and regulations, project owner has appointed a specialized institute to evaluate the potential negative environment impact on local people arising from this project in order to take effective measures to cope with. The Environment Impact Assessment (EIA) of this project has got the final approval from Shenyang Environment Protection Bureau on February 14, 2007 with Shen Environment Protection Approval NO, of 2007[23].
The result of EIA shows that this project will not exert much negative impact on surrounding environment, In addition, during construction and operation period, a series of practical measures will be implemented based on comments from the approval letter of the EIA.

The conclusion is as followings:

Noise:
Due to the operation of the plant, there might be some noise. To minimize this noise, all the engines which will result in high noise will be placed in a sealed container with anti-sound materials and muffle will also be installed outside. At the same time rubber cushion is used for reducing vibration,
Except for the above measures, topography will also obstruct some noise. In this way the noise will be greatly reduced. Furthermore, the surrounding area of the plant will meet “Standard of noise at boundary of industrial enterprises” GB12348-90.

Biotic environment impact:
The land where the landfill locates is a barren field without plants. After construction of this project, appropriate covering of the landfill will be done, it enables the landfill owner to reshape the waste body and make it fit into the landscape.
On the other hand, extraction of several toxics, odorous and GHG gases has a positive influence on the environment.

Water:
During the operation, the separated condensate will be sprayed back to the landfill site after centralized collection.

Air &climate:
The components in the exhausted air after biogas is utilized for electricity generation is simple, its main pollutants are SO_2, and smoke dust. Emission density of SO_2 is 47.04mg/m^3 with the amount of 0.7 kg/h; Emission density of is smoke dust is 47.6mg/m^3 with the amount of 0.71 kg/h which are much lower than the emission standard for Class II zone in Time Period II specified in Integrated Emission Standard of Air Pollutants (GB 16297-1996). Besides, the biogas will be treated with filtering and desiccation system to lower the content of H_2S, NO_x and dust to ensure that the emission of exhaust gas will meet the national standard.

Safety:
Risk preventing measures are going to be taken on LFG collecting system to guarantee LFG is safely delivered. Other risk like fire and explosion will be minimized by taking some effective measures.
All in all, this project will not have a prominent negative impact on environment on the contrary, will be helpful for local environment protection and improve atmosphere's quality.

Waste:
The project does not result into any increase of waste production.

D.2. If environmental impacts are considered significant by the project participants or the host Party, please provide conclusions and all references to support documentation of an environmental impact assessment undertaken in accordance with the procedures as required by the host Party:

Even though this project will not generate a big impact on surrounding environment, the project owner still did EIA according to the requirement of relevant Chinese laws and regulations, and approval for EIA has been issued by Shen Environment Protection Bureau on February 14, 2007.

SECTION E. Stakeholders' comments

E.1. Brief description how comments by local stakeholders have been invited and compiled:

On July 18th, 2006 a meeting was carried out between Asja Ambiente Italia S.p.A. employees, Lao Hu Chong landfill operators, the local authorities of the Government of the City of Shenyang and experts from Shenyang Normal University, Shenyang Environmental Protection Bureau, Shenyang Environmental Science Institute, Shenyang University.
The event was also advertised on the Shenyang Newspaper of the 29th June 2006, with the aim to involve private citizens, Several of them attended the Stakeholders' Consultation Meeting showing great interest.
The Meeting was organized in order to illustrate and discuss the future activities that will have to be carried out in the Lao Hu Chong Landfill owned by Shenyang Laohuchong Municipal Solid Waste Management Co, Ltd.

Totally there were 44 stakeholder representatives participated the meeting, respectively from local village, common citizens, Environment Protection Bureau, professors from institutes and local government. Every representative showed a great interest to this project. Project owner and technology provider give a detailed introduction of the project, and comments from stakeholders were collected. In addition all the participants were invited to fill in a questionnaire.

E.2. Summary of the comments received:

During the meeting several questions were raised and the two project companies answered as follows:

- Since it is a waste related project, will the proposed project exert environment impact on local villagers?

Actually it is an environment friendly project. The purpose is to reduce GHG and simultaneously abate the odorous smell from the landfill.

- As we all know biogas is a kind of dangerous gas, because if it is not properly treated, it might cause explosion, is this project 100% safe?

First of all if biogas is correctly collected and managed, there is not any risk. In addition, Asja Ambiente Italia has many years experience in this kind of projects and has successfully run more than 20 similar plants and all of them are 100% safe.

- Which are the benefits for the local villagers?

Since there will be no emission of methane, the quality of the air will be improved, besides, there will be positive impact on local economy, as employing and training local workers that will be required for construction, operation and maintenance of the plant.

The summary of suggestions given by the stakeholders is as follows:

"We hope you can turn your project into reality as soon as possible…"
(Academic staff, landfill operators and private citizens)

"The project can also facilitate local economy and provide more chance for employment, so we think it is a good project."
(Landfill operator)

”I feel this is a very good project, you should spread it and develop it.”
(Public officer)

”We need more advanced technology of landfill treatment in other cities.”
(Landfill operator)

E.3. Report on how due account was taken of any comments received:

No further adjustment was made since there were no negative comments.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

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Annex 2

INFORMATION REGARDING PUBLIC FUNDING

No funds from public national or international sources will be used in any aspect of the proposed project.

Annex 3

BASELINE INFORMATION

Tab. Annex 3. 1: Input Data for emission reductions calculation

Symbol	Item	Adopted Value	Unit	Source
AC%	Percentage of electrical energy used for the biogas plant auto-consumptions	4.8	%	Used for electricity imported estimation. Asja Ambiente Italia S.p.A. experience, Asja has 22 biogas plants in Italy and has been operating this type of technology for 11 years. For each plant, Asja makes all the necessary research as regards parameters that help to estimate the potential LFG generation and the electricity generation capacity.
HV_{CH4}	Methane Heating Value	8,250	kCal/Nm^3 CH_4	Used for baseline calculations. UNI 10389.
GER	Generator Efficiency Rate	30	%	According to Asja Ambiente Italia S.p.A. experience and manufacturer's specifications.
ECF	Energy Conversion Factor	860	kCal/kWh	Used for baseline calculations. It is a fixed conversion factor.
CE	Biogas Capture Efficiency	40	%	Asja Ambiente Italia S,p,A, experience,
BWH	Blowers working hours	8,000	h/y	Asja Ambiente Italia S.p.A. experience.
$\eta_{flare,h}$	Flare Efficiency (enclosed flare)	90	%	"*Tool to determine project emissions from flaring gases containing methane*" default value for enclosed flares.
ECF	Energy Conversion Factor	860	kCal/kWh	Used for baseline calculations. It is a fixed conversion factor.
MCF	Methane correction factor	100	%	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
DOC_f	Fraction of degradable organic carbon dissimulated	55	%	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
F	Fraction by volume of CH_4 in landfill gas	50	%	IPCC 2006 Guidelines for National Greenhouse Gas Inventories

Equations used in order to calculate k and L_0:

Methane Potential (Lo)

In IPCC Good Practice Guidelines and Uncertainty Management in National Greenhouse Gas Inventories, the following equation estimates DOC using default carbon content values:

$$DOC = (0.4 \times A) + (0.17 \times B) + (0.15 \times C) + (0.3 \times D)$$

Where:

A = Fraction of MSW that is paper and textiles

B = Fraction of MSW that is garden waste, park waste or other non-food organic putrescribles

C = Fraction of MSW that is food waste

D = Fraction of MSW that is wood or straw

Waste Stream	Waste Composition
i	**ton i/ton waste**
Paper and textiles	30%
Garden and park waste, and other (non-food) organic putrescibles	28%
Food Waste	25%
Wood	8%
Other Waste	9%
Total	100%

For Lo calculation the formula given in the IPCC Good Practice, should also be applied:

$$Lo = MCF \times DOC \times DOC_f \times F \times 16/12$$

Where:

MCF = Methane correction factor in year x, The IPCC MCF default values of 1 and 0.6 were applied to the managed and uncategorised sites respectively, In this case, 1 is the appropriate factor because Shenyang is considered a well managed landfill.

DOC = Degradable organic carbon in year x,

DOC_f = Fraction of DOC dissimulated, 0.55 is the medium biodegradable fraction in China[10].

F = Fraction by volume of CH_4 in landfill gas, IPCC takes the default value of 50 percent.

[10] http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/5_Volume5/V5_3_Ch3_SWDS.pdf (table 3.5)

MCF	100%	%
DOC	22.91%	ton C/ton waste
DOCf	0.55	
F	50%	%
Carbon conversion factor	1.33333	ton CH4/ton C
CH4 density	0.0007168	ton CH4/mc CH4
T	19	°C
DOCf	0.55	
Lo	116.3	mc CH4/ton waste

This data gives a Lo value of 116 m^3 CH_4/tonne Waste.

Methane Generation Rate Constant (k)

The methane generation rate constant represents the first-order biodegradation rate at which methane is generated following waste placement. This constant is influenced by moisture content, the availability of nutrients, pH, and temperature. The moisture content within a landfill is one of the most important parameters affecting the gas generation rate, Moisture serves as a medium for transporting nutrients and bacteria.

The moisture content within a landfill is influenced primarily by the infiltration of precipitation through the landfill cover. Other factors that affect the moisture content in the waste and the rate of gas generation include the initial moisture content of the waste; the amount and type of daily cover used at the site; the permeability and time of placement of final cover; the type of base liner; the leachate collection system; and the depth of waste in the site.

The methane generation rate constant has different default values depending on the rainfall value, in the following table default values for k are shown:

Tab. Annex 3. 2: Methane generation rate constant (k)

ANNUAL PRECIPITATION (mm/yr)	k (per year)
0 - 249	0.040
250 – 499	0.050
500 - 999	0.065
at least 1000	0.080

A review of the Shenyang's annual rainfall data, landfill operational practices and site conditions was made. The value for the Shenyang's average rainfall is 735 mm.

Based on these considerations, a value for k of 0.0668 was selected for the site taken into account the site and operation conditions.

Landfill site

Before the installation of the biogas plant all the landfill gas was emitted to the atmosphere. In order to prevent firing or explosions and to comply with local regulations[11], a system made of a vertical wells was installed. This vertical wells were not efficient and were dismantled in order to build a high-quality biogas extraction and collection system for the project activity.

Below some characteristics about the landfill management:

Thickness of cover

(1) Thickness of each layer

The thickness of each layer is 2.6 m[12] with pressed waste thickness of 2.4 m and clay thickness of 0.2 m.

(2) Daily clay cover

When the waste is press to 2.4 m, 20 cm clay will be covered on it.

(3) Final cover

When the filled waste reaches designed height, clay with good water isolation should be used to seal landfill. The pressed clay thickness should be 100cm. After that vegetable earth with thickness of 100cm should be covered.

According to GB16889-997 "*Urban Solid Waste Pollution Control Standard*" and CJJ17-88 "*Urban Solid Waste Hygiene Landfill Technical Standard*", permeability of landfill impermeable layer $K \leq 1 \times 10^{-7}$ cm/s.

2The bottom of the landfill is clean. To prevent pollution of underground water, clay of no less than 2m thickness is compulsory to be covered on the bottom to guarantee a stable bottom layer. In addition the ground of landfill should be levelled with no less than 2% of slope from south part to north part..

Slope surface of landfill should be clean. For clay slope no less than 2m of pressed clay should be guaranteed. And the slope should be levelled by machine or labour. For rock slope, mixture of concrete and cement mortars should be applied.

HDPE layer should be paved[13]. It should be flat without gauffer and try to reduce welding seams.

Impermeable material is HDPE layer with permeability of 10^{-12}cm/s, which meet the requirement of international standard and standard issued by Chinese Ministry.

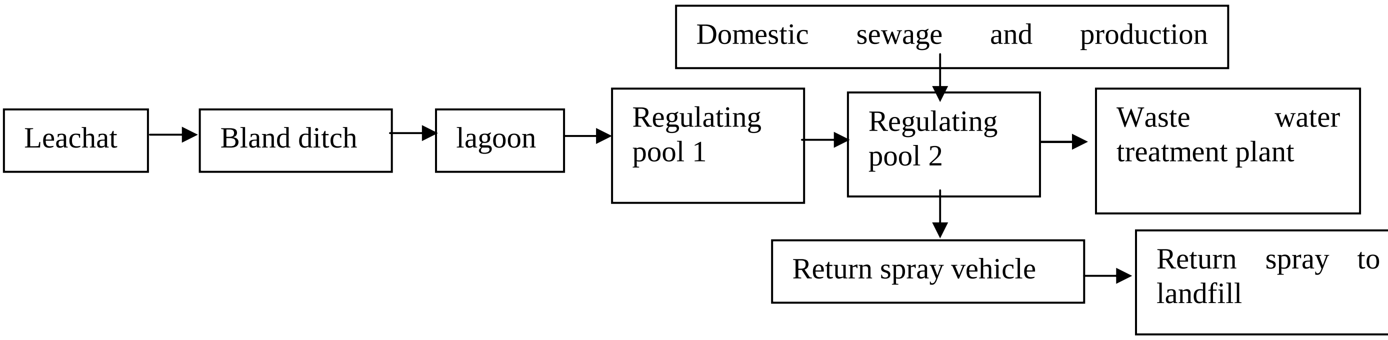
[11] Urban Solid Waste Landfill Technology Standard

[12] The "Urban Solid Waste Hygiene Landfill Technical Standard" require a layer of a thickness of 2-3, and the maximum thickness is 6 m.

[13] The "Urban Solid Waste Hygiene Landfill Technical Standard" require a basement construction made of HDPE layer.

Leachate collection technique

Flow chart



North East Power Electric Grid Emission Factor Calculation Process and Data

Tab. Annex 3. 3: OM Emission Factor of North East Electricity Power Grid (2003)

Fuel	Unit	Net thermal value	Unit	Emission factors (tC/TJ)	Oxygenation rate	Liao Ning	Ji Lin	Hei Long Jiang	Amount of emission
		A		B	C	D	E	F	J=(D+E+F+G)*A*B*C*44/ 12/10000
Raw coal	10000 ton	20908	MJ/t	25.8	100	3556.51	2006.66	2763.62	164,695,312.95
Clean coal	10000 ton	26344	MJ/t	25.8	100	70.83		3	1,839,948.73
Other washed coal	10000 ton	8363	MJ/t	25.8	100	617.04	15.9	53.41	5,429,988.02
Coke	10000 ton	28435	MJ/t	25.8	100				0.00
Coke oven gas	100million m³	16726	MJ/t	12.1	100	1.66			123,184.76
Other coal gas	100million m³	5227	MJ/t	12.1	100	5.31			123,141.32
Raw oil	10000 ton	41816	MJ/t	20	100	3.39			103,954.58
Gasoline	10000 ton	42652	MJ/t	20.2	100	0.32	0.34		20,850.00
Diesel	10000 ton		MJ/t	18.9	100				0.00
Fuel oil	10000 ton	41816	MJ/t	21.1	100	14.87	0.7	4.32	643,474.23
LPG	10000 ton	50179	MJ/t	17.2	100	1.55			49,051.65
Refinery gas	10000 ton	46055	kJ/m3	18.2	100	4.03		0.46	137,995.82
Natural gas	100million m³	38931	kJ/m3	15.3	100		0.04	4.47	984,997.12
Other petroleum products	10000 ton	38369	kJ/m3	20	100				0.00
Other coking products	10000 ton	28435		25.8	100				0.00
Other energy	10000 ton standard coal	0		0	100	29.38			0.00

total		a							**174,151,899.19**
Thermal power plant output	MWh	b				79,751,000	29,739,000	48,493,000	
Proportion of plant self use		c				7.17%	7.32%	8.48%	
Amount connected to the grid from thermal power plant	MWh	d=b*(1-c)				74,032,853.3	27,562,105.2	44,380,793.6	**145,975,752.1**

OM emmission factor

a : southern electric power grid total output (tCO2) **174,151,899.19**

d: amount connected to the grid from thermal power plant (MWh) **145,975,752**

sources：

China Electric Yearbook 2004

Tab. Annex 3. 4: OM Emission Factor of North East Electricity Power Grid (2004)

Fuel	Unit	Net thermal value	Unit	Emission factors (tC/TJ)	Oxygenation rate	Liao Ning	Ji Lin	Hei Long Jiang	Amount of emission
		A		B	C	D	E	F	J=(D+E+F+G)*A*B*C*44/12/10000
Raw coal	10000 ton	20908	MJ/t	25.8	100	4144.2	2310.9	3084.8	188,689,376.82
Clean coal	10000 ton	26344	MJ/t	25.8	100	84.75	1.09	4.88	2,260,871.59
Other washed coal	10000 ton	8363	MJ/t	25.8	100	577.67	14.26	61	5,165,589.10
Coke	10000 ton	28435	MJ/t	25.8	100				0.00
Coke oven gas	100million m³	16726	MJ/t	12.1	100	4.83	2.91		574,367.49
Other coal gas	100million m³	5227	MJ/t	12.1	100	57.33	4.19		1,426,676.89
Raw oil	10000 ton	41816	MJ/t	20	100				0.00
Gasoline	10000 ton	42652	MJ/t	20.2	100	2.04	1.16	0.24	108,672.75
Diesel	10000 ton		MJ/t	18.9	100				0.00
Fuel oil	10000 ton	41816	MJ/t	21.1	100	12.81	1.78	2.86	564,536.21
LPG	10000 ton	50179	MJ/t	17.2	100	2.19			69,305.23
Refinery gas	10000 ton	46055	kJ/m3	18.2	100	9.79		1.14	335,923.02
Natural gas	100million m³	38931	kJ/m3	15.3	100		0.03	2.53	559,111.45
Other petroleum products	10000 ton	38369	kJ/m3	20	100				0.00
Other coking products	10000 ton	28435	kJ/m3	25.8	100				0.00
Other energy	10000 ton standard coal	0		0	100	26.97	5.07		0.00
total		a							**199,754,430.55**
Thermal power plant output	MWh	b				84,543,000	33,242,000	53,482,000	

Proportion of plant self use		c				7.21%	7.68%	7.84%	
Amount connected to the grid from thermal power plant	MWh	d=b*(1-c)				78,447,449.7	30,689,014.4	49,289,011.2	**158,425,475.3**

OM emmission factor

a : southern electric power grid total output (tCO2) **199,754,430**

d: amount connected to the grid from thermal power plant (MWh) **158,425,475**

sources

China Electric Yearbook 2005

Tab. Annex 3. 5: OM Emission Factor of North East Electricity Power Grid (2005)

Fuel	Unit	Net thermal value	Unit	Emission factors (tC/TJ)	Oxygenation rate	Liao Ning	Ji Lin	Hei Long Jiang	Amount of emission
		A		B	C	D	E	F	J=(D+E+F+G)*A*B*C*44/12/10000
Raw coal	10000 ton	20908	MJ/t	25.8	100	4305.41	2446.13	3383.21	200,454,895.94
Clean coal	10000 ton	26344	MJ/t	25.8	100				0.00
Other washed coal	10000 ton	8363	MJ/t	25.8	100	524.74	19.26	24.16	4,494,939.89
Coke	10000 ton	28435	MJ/t	25.8	100				0.00
Coke oven gas	100million m³	16726	MJ/t	12.1	100	1.03	3.57	0.68	391,816.59
Other coal gas	100million m³	5227	MJ/t	12.1	100	12.62	8.37		486,767.69
Raw oil	10000 ton	41816	MJ/t	20	100	1.16			35,571.48
Gasoline	10000 ton	42652	MJ/t	20.2	100	1.18	1.48	0.57	102,038.65
Diesel	10000 ton	41816	MJ/t	18.9	100				0.00
Fuel oil	10000 ton	41816	MJ/t	21.1	100	9.32	2.46	1.55	431,247.43
LPG	10000 ton	50179	MJ/t	17.2	100	0.12			3,797.55
Refinery gas	10000 ton	46055	kJ/m3	18.2	100	5.48		1.32	208,991.45
Natural gas	100million m³	38931	kJ/m3	15.3	100		0.84	2.24	672,680.96
Other petroleum products	10000 ton	38369	kJ/m3	20	100				0.00
Other coking products	10000 ton	28435	kJ/m3	25.8	100				0.00
Other energy	10000 ton standard coal	0		0	100	16.18			0.00
total		a							**207,282,747.62**

Thermal power plant output	MWh	b				83,697,000	35,294,000	58,000,000	
Proportion of plant self use		c				7.03%	6.59%	7.96%	
Amount connected to the grid from thermal power plant	MWh	d=b*(1-c)				77,813,100.9	32,968,125.4	53,383,200.0	**164,164,426.3**

OM emmission factor

a : southern electric power grid total output (tCO2) **207,282,747**

d: amount connected to the grid from thermal power plant (MWh) **164,164,426**

sources

China Electric Yearbook 2006

Tab. Annex 3. 6: Operating Margin Emission Factor of North East Electricity Power Grid

		2003	2004	2005	OM in average
Total CO2 emission	tCO2e	174,151,899	199,754,431	207,282,747.62	1.240358
Electricity generation	MWh	145,975,752	158,425,475	164,164,426.30	

$EF_{OM,y}$ = 1.240358 tCO_{2e}/MWh

Tab. Annex 3. 7: Emission Proportion Calculation of Fuels of Solid, Liquid, and Gas Accounting For Total CO_2 Emission

Fuel Type		unit	Liao Ning	Ji Lin	Hei Long Jiang	total	Average low heating (MJ/t,km3)	EF (tC/TJ)	oxidation rate (%)	emission account (tCO2e)	Proportion
coal	raw coal	10,000 ton	4305.41	2446.13	3383.21	10,134.75	20,908	25.80	100.00	200,454,895.94	-
	cleaned coal	10,000 ton				0.00	26,344	25.80	100.00	0.00	-
	other washed coal	10,000 ton	524.74	19.26	24.16	568.16	8,363	25.80	100.00	4,494,939.89	-
	cooked coal	10,000 ton				0.00	28,435	29.20	100.00	0.00	-
	sub-total	10,000 ton				0.00	-	-	-	***204,949,835.83***	98.89%
petroelum	crude oil	10,000 ton	1.16			1.16	41,816	20.00	100.00	35,571.48	-
	gasoline	10,000 ton				0.00	43,070	18.90	100.00	0.00	-
	kerosene	10,000 ton				0.00	43,070	19.60	100.00	0.00	-
	diesel	10,000 ton	1.18	1.48	0.57	3.23	42,652	20.20	100.00	102,038.65	-
	fuel oil	10,000 ton	9.32	2.46	1.55	13.33	41,816	21.10	100.00	431,247.43	-
	other petroleum products	10,000 ton				0.00	38,369	20.00	100.00	0.00	-
	sub-total	10,000 ton				0.00	-	-	-	***568,857.56***	0.27%
gas	natural gas	10,000 ton		8.4	22.4	30.80	38,931	15.30	100.00	672,680.96	-
	coking gas	10,000 ton	10.3	35.7	6.8	52.80	16,726	12.10	100.00	391,816.59	-
	other gas	10,000 ton	126.2	83.7		209.90	5,227	12.10	100.00	486,767.69	-
	liquid gas	10,000 ton	0.12			0.12	50,179	17.20	100.00	3,797.55	-
	refined dry gas	10,000 ton	5.48	0.00	1.32	6.80	46,055	15.70	100.00	180,283.83	-
	sub-total	10,000 ton	-	-	-	-	-	-	-	***1,735,346.61***	0.84%
	total									**207,254,040.00**	100%

Tab. Annex 3. 8: EF calculation of coal-fuelled electricity, gas-fuelled electricity and oil-fuelled electricity

	Parameter	Power supply efficiency	Fuel emission factor (tc/TJ)	Oxidation factor (%)	EF (tCO2e/MWh) =3.6/J/1000*F*G*44/12
coal-fuelled power plant	**EFCoal,Adv**	**35.82%**	**25.80**	**100.0**	**0.9508**
gas-fuelled power plant	**EFGas,Adv**	**47.67%**	**15.30**	**100.0**	**0.4237**
oil-fuelled power plant	**EFOil,Adv**	**47.67%**	**21.10**	**100.0**	**0.,5843**

$EF_{thermal} = \lambda_{coal} \text{ x } EF_{coal} + \lambda_{oil} \text{ x } EF_{oil} + \lambda_{gas} \text{ x } EF_{gas} = \mathbf{0.9453\ tCO_{2e}/MWh}$

Tab. Annex 3. 9: 2005 North East Electric Power Grid Installation Capacity

Installation Capacity	Liao Ning	Ji Lin	Hei Long Jiang	Total
(MW) thermal power	15,999.0	6,359.4	11,575.6	33,934.0
(MW) hydropower	1,403.9	3,720.8	846.7	5,971.4
(MW) nuclear power	0.0	0,0	0.0	0.0
(MW) wind and others	135.5	85.4	52.4	273.3
Total	17,538.4	10,165.6	12,474.7	**40,178.7**

Source: China Electric Yearbook 2006

Tab. Annex 3. 10: 1999 North East Electric Power Grid Installation Capacity

Installation Capacity	Liao Ning	Ji Lin	Hei Long Jiang	Total
(MW) thermal power	12,425.7	4,583.1	10,128.1	27,136.9
(MW) hydropower	1,240.0	3,508.2	774.5	5,522.7
(MW) nuclear power	0.0	0.0	0.0	0.0
(MW) wind and others	22.9	0.0	0.0	22.9
Total	13,688.6	8,091.3	10,902.6	32,682.5

Source: China Electric Yearbook 2000

Tab. Annex 3. 11: 1998 North East Electric Power Grid Installation Capacity

Installation Capacity	Liao Ning	Ji Lin	Hei Long Jiang	Total
(MW) thermal power	12,560.3	4,428.6	9,116.0	26,104.9
(MW) hydropower	1,223.1	3,474.7	784.5	5,482.3
(MW) nuclear power	0.0	0.0	0.0	0.0
(MW) wind and others	17.0	0.0	0.0	17.0
Total	13,800.4	7,903.3	9,900.5	**31,604.2**

Source: China Electric Yearbook 1999

Tab. Annex 3. 12: Calculation of Building Margin Emission Factor for North East China Electric Power Grid

	1998	1999	2005	Newly added capacity	Proportion
(MW) thermal power	26,104.9	27,136.9	33,934.0	7,829.1	**91.31%**
(MW) hydro power	5,482.3	5,522.7	5,971.4	489.1	5.70%
(MW) nuclear power	0.0	0.0	0.0	0.0	0.00%
(MW) wind power	17.0	22.9	273.3	256.3	2.99%
(MW) total	***31,604.2***	***32,682.5***	***40,178.7***	***8,574.5***	100%

$EF_{BM,y}$ = 0,9453 tCO_{2e}/MWh × 91,31% = 0.8632 tCO_{2e}/MWh

Annex 4

MONITORING INFORMATION

Introduction
According to ACM0001, direct monitoring will be conducted on the LFG captured, destroyed by flare and used for power generation.

An operative manual of the project will be available. This manual will have the applicative documents of the monitoring plan (description of the project and responsibilities, operative procedures for measurements and handlings of data and details about internal audits, etc.)

Two operators will collect necessary data for the monitoring plan and a Project Manager will verify the correct application of the operative procedures written in the manual.

The monitoring plan is described below:

(1 DATA MONITORED
The monitoring procedures will measure:

- Landfill gas collected from project wells.
- Landfill gas flow into flare.
- Landfill gas flow into power plant.
- Pressure of the landfill gas.
- Methane content in the landfill gas.
- Flare temperature.
- Emissions from flaring.
- Electricity imported from the power grid.
- Electricity exported to the power grid.
- Operation of the energy plant and flare.
- Local and national regulatory framework.

All the equipments of the plant are connected through a Programmable Logic Control (PLC) that let the operator quickly check the unit's main variables through a user-friendly interface.

(2 DATA COLLECTED, FREQUENCY AND QUALITY CONTROL

Landfill gas flow
The landfill gas flow will be measured by means of a flow meter. Three flow meters will be installed, one to measure the LFG flow into flare, other for the LFG flow into the engines and another one in order to measure the landfill gas collected from project wells. One flow meter will be installed for each flare.
For reporting purposes, these parameter is generally required to be normalized to 0°C and 1.01325bar. In order to normalized the volume measured by the flow meter to a standard temperature and pressure, a temperature transmitter for a range of 0/100°C and a pressure transmitter for a range of 0/250mbar will be used.
To limit the time of operation with no flow signal in case of failure, the flow meter will be exchanged as soon as possible.

Despite this quick exchange the degassing installation operates for a short time without flow signal and CO_2 values.
To determine the flow during this time span, the average flow of the last 7 days will be used and so it is possible to calculate the quantity of CO_2 reduced. The chance of failure of the flow meter is very small.

Methane content in the landfill gas
Methane content in the landfill gas will be measured by a gas analyzer with an infrared ray system analysis, with a scale range of 0-100 %Vol.
The CH_4 analyzer will be calibrated according to its calibration protocol.
To limit the time of operation with no signal, in case of gas analyzer failure, this analyzer will be replaced with a another one as soon as possible.
Despite this quick exchange, the degassing installation operates for a short time without CH_4 signal.
To determine the CH_4 content during this time span the average CH_4 content of the last 7 days will be used.

Electricity imported and exported by power grid
Electricity imported and exported by power grid will be measured by energy meters that are sealed. Since electricity meters belong and are managed by the Power Supply Co. the amount of electricity will be proven by the official electricity bills.

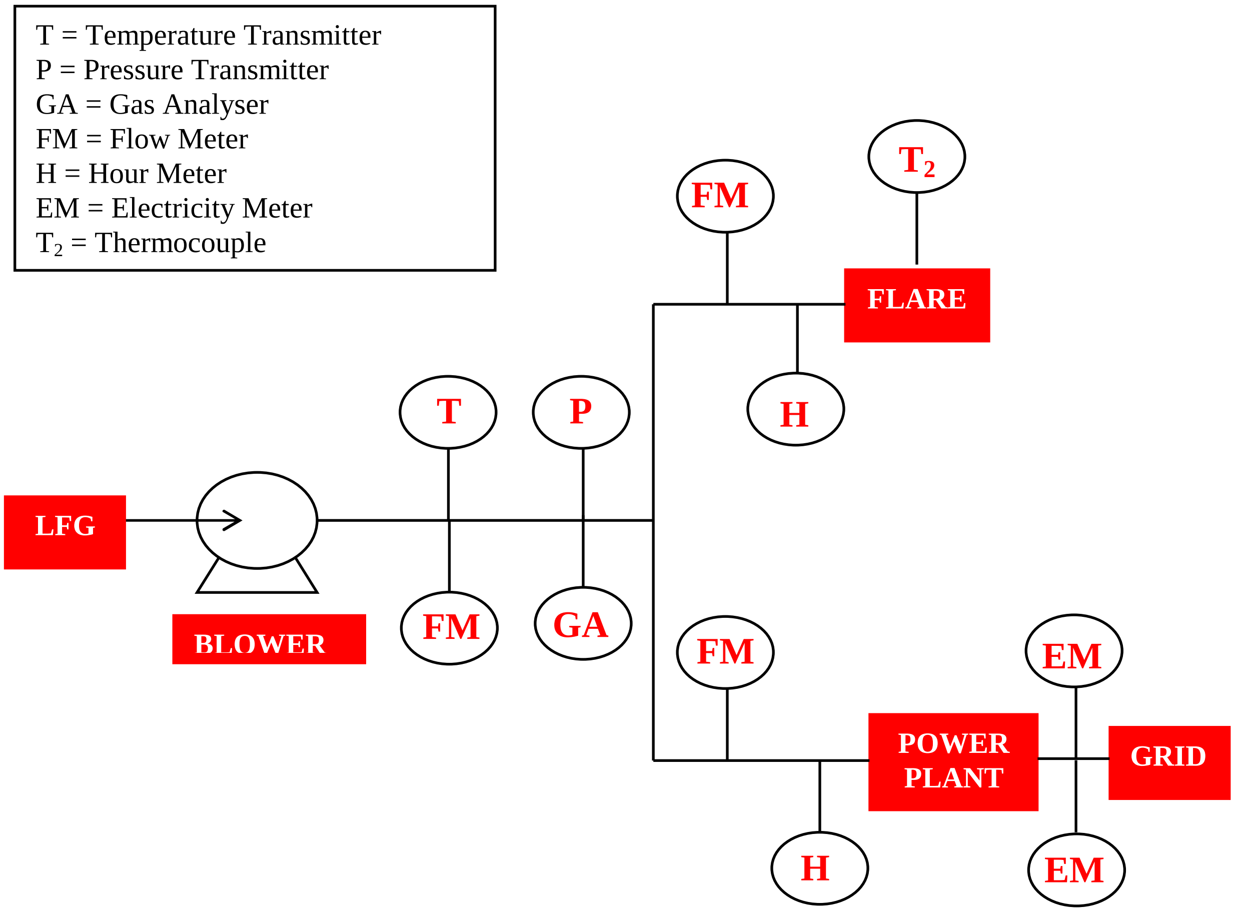
Local and national regulatory framework
As stated on the Operation Manual available on-site, the local and national regulatory framework (related to the project) will be monitored on an annual basis in order to verify that the project complies with the local and national regulation.

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*" and the manufactures' specifications.

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.
The flow meter detects no landfill gas stream and no CO_{2eq} will be counted and no special actions are possible to avoid this.

(3 MONITORING EQUIPMENTS AND INSTALLATION
All measurements equipments are maintained and managed on general technical standards. The Operation Manual will determine the quality control regime for each key that includes regular maintenance and calibration. The measurement and recording will be done in an accurate and transparent manner.
In order to determine the quantity of ERs generated during the project activity the following equipments will be installed.

Fig. 1: Monitoring points



(4 CALCULATION ON THE AMOUNT OF ERs

The greenhouse gas emission reduction achieved by the project activity during a given year "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.

(5 MONITORING ORGANIZATION
To assure a correct monitoring, the training of the Chinese staff will be organised.

People will be trained on the following subjects:

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

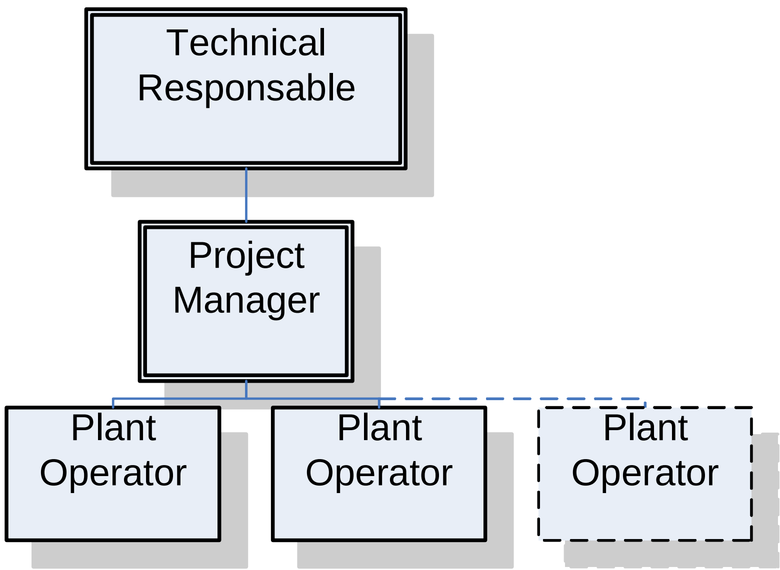
Chosen trainees will have a good understanding the processes and installation technology of the landfill gas extraction.
The personnel will be trained before the plant enters into operation.
A guidebook about landfill gas extraction and utilization in English and Chinese will also be available.

The guidebook will have:

- Operation manual.
- Maintenance instructions.
- Description of the main parts of the equipment.

Additionally the telephone helpdesk will be available with direct connection to Italy, where experts of Asja Ambiente Italia S.p.A. can give technical advice.

Fig. 2: Organization Chart



(6 CALIBRATION

All measurement instruments will be subject to regular calibration. The calibration procedures in the "Project Management Manual" define the management, checks and calibration intervals of the equipment used for process control.

PM will be responsible for the management of the pieces of equipment needing regular calibration for the biogas installations.

The regular check and calibration will be entrusted to the operators. The PM will be responsible for checking the equipment's proper working order, as well as checking and storing up the calibration certificates and records. Calibration documents will be kept for all the equipments until two years after the end of the crediting period.

(7 DATA MANAGEMENT SYSTEM

The PLC will receive continuously the value of the parameters monitored on-site and automatically generate spreadsheets that will be achieved. The information archived will be aggregated hourly, monthly and yearly in a standard format for the preparation for reporting purposes.

The Project Manager will implement a document control system to ensure that all the necessary documents (operation manual, drawings, maintenance, calibration instructions and reported data) are available, accurate and stored in a proper manner. Monitored data and Monitoring Sheets will be copied to magnetic media every 6 months and stored in appropriate archives.

All data, including calibration records and Monitoring Reports will be kept until 2 years after the crediting period.

(8 AUDIT REVIEW

Internal audits will be perform by an auditor not involved in the daily operation of the biogas plant in order verify that all the reported data is correct and accurate, to assess the implementation of the Monitoring Plan and to prepare the Monitoring Report.

All the audit findings, including corrective actions, will be recorded and will be available on-site at the time of verification.

(9 EMERGENCY PREPARDNESS

The "Emergency Plan" consists of all extraordinary measures or actions to be taken in order to tackle dangerous occurrences and limit the damage to the health and safety of workers.

All employees working at the Shenyang plant are responsible for correctly implementing the guidelines set forth in this procedure.

Each employee must diligently perform his/her assigned tasks, without nevertheless risking his or her safety when taking measures aimed at bringing the emergency under control.

The PM (or the operator whenever the PM is not present) has the task of reporting the emergency to external rescue providers (Fire brigade or First aid) dialing the emergency numbers posted in the office and providing rescuers with all information concerning the fire size, materials involved, number of injured people etc.

The PM (or the operator whenever the PM is not present) is in charge of giving the verbal order to evacuate the plant.

Emergency measures

1 General guidelines

In order to guarantee a prompt response to every emergency the following conditions must always be met:

- Firefighting devices must always be kept visible and efficient;
- Combustible products must be kept in their specific storage areas;
- Smoking must be prohibited in areas where there may be a risk of fire or explosion;
- Work activities involving the use of naked flames must be performed only after having checked with special detection equipment the absence of dangerous atmospheres
- A fire extinguisher must be kept in proximity of the landfill areas where biogas network construction activities are being carried out
- All personnel must receive regular theoretical and practical training on fire fighting, quick evacuation and first aid to injured people.

In case of danger, the following safety behaviour rules must be followed:

- keep calm and avoid spreading panic among the others;
- strictly adhere to the rules set forth in this emergency plan;
- provide help to those who need it;
- leave quickly, following the directions provided by the signs;
- do not re-enter the plant until normal conditions are restored and only if permitted by the RSPP - Safety and prevention services manager.

2 Fire in suction station or power production areas

In case of fire, the operator must perform the following steps:

- Immediately Inform the PM in charge of the plant;
- make other people, if present, move away from endangered areas;
- Block the biogas (fuel) flow operating the interception valves whose position is showed in the plant layout and by the special signs;
- Cut off the plant power supply using the emergency main switch;
- Find and use fire fighting equipment trying to put out the fire without risking his/her safety ;
- Move away flammable or combustible substances (e.g. Lubricating oil, paper, cardboard etc) , if any, placed near the area involved in the fire
- In case of a severe fire call the fire brigade;
- Once the fire has been put out, carefully check for possible hidden pockets of fire and do not demobilize until the possibility of a fire re-start is totally ruled out.
- The resumption of plant activities shall be possible only after the RSPP - Safety and prevention services manager, together with the plant PM, have checked plant efficiency section by section.

3 Gas leakage and risk of explosion

Gas may leak from damaged pipes, broken flanges or ruptured welds, damaged valves in the biogas feed line.

In case a gas leak is detected by an operator, the following steps must be carried out:

- Immediately Inform the PM in charge of the plant;
- Block the biogas (fuel) flow operating the interception valves whose position is showed in the plant layout and by the special signs;
- Cut off the plant power supply using the emergency main switch;
- Stop the gas flow leaking out of the pipes closing the gas feed line valves at the gas flow adjustment stations and, if needed, also at the well-heads
- Avoid using anything that may trigger a fire or an explosion.

4 Liquid product spillage

Liquid products available on site are, for the most part, comprised of mineral oils for the lubrication of motors, used oils, ethylene glycol.

Liquid products are stored in areas equipped with containment tanks.

In case liquids spill out from broken pipes, broken valves, or due to truck loading/unloading operations on the plant premises, the following emergency measures must be taken:

- Inform the PM in charge of the plant;
- Wear appropriate personal protective equipments for hand protection (protective gloves against chemicals);
- Mark off the affected area from surrounding spaces and personnel using marking tape as required by the size of the area involved
- avoid anything that may give off sparks;
- prevent spilled liquid from reaching drain holes or surfaces which are not impermeable;
- assess the risk of a fire breaking out: if there is a risk of fire, call the fire brigade
- disconnect from power supply any equipment involved in the accident avoiding direct contact

In case a visible oil leak involves the engine room, immediately inform the PM who may decide to stop the engine involved;
Remove the spill using absorbing material designed for this propose or, alternatively, sand if a substance is spilled onto unpaved surfaces, dig out a few cm of contaminated soil with a shovel.

The contaminated material removed or the material used to absorb the spill must be put in a special waste container, then classified and registered in the plant waste registry within one week of the spillage.

In case the event has involved a rainwater collection system, specially trained staff must intervene (e.g. specialized cleaning services company, equipped with suitable equipment such as water jet devices upon request to intervene on site by the PM or by the RSPP-Safety and prevention services manager, who will evaluate the need to report the event to external monitoring bodies (e.g. local or regional organisations in charge of environmental emergencies)

5 Plant evacuation

In case serious dangers which cannot be tackled by plant personnel are identified by plant operators or by the PM, evacuation will become necessary.

Everyone will have to leave the plant premises and gather at the collection point as indicated on the plant layout and on the special safety signs.

If possible without putting one's personal safety at risk, the plant safety must be restored by operating the emergency main switch and by closing the plant biogas inlet valve.

Contractors staff present on site, if any, shall also get out of the plant immediately and gather at the collection point.

The following people will have to be informed:

- The PM in charge of the plant (if not already present on site);
- The Technical Director;
- The Fire Brigade (if needed);
- The First aid stations (if needed).