CLEAN DEVELOPMENT MECHANISM
PROJECT DESIGN DOCUMENT FORM (CDM-PDD)
Version 03 - in effect as of: 28 July 2006

CONTENTS

Annexes

SECTION A. General description of project activity

A.1 Title of the project activity:

Project title: Liaoning Landfill Gas Recovery and Utilization Project
Document version: 3.0
Date: 12 Feb 2009

A.2. Description of the project activity:

The purpose of the proposed CDM project activity is to collect and destroy the landfill gas (LFG) generated at the following three landfills: Zhaojiagou landfill, Gaoguanling landfill and Langshan landfill. For each of these landfills, a flare will be installed first in March 2009 to destroy the collected LFG. The installation of one set of boiler will not be finished until June 2009 since the construction is difficult during the winter. The collected LFG will be combusted in boilers to produce hot water which will be supplied to local public bathrooms, hotels and other heat recipients.

The proposed project activity will led to significant CO_2 emission reductions by two ways: the destruction of methane through LFG collection and combustion/flare, as well as the thermal energy production to reduce coal consumption which leads to both CO_2 emission and local pollution. It's estimated that during the first ten years' operation it will lead to the emission reductions of 634,667 tCO2e.

All the three landfills included in this CDM project activity are located in Liaoning province, People's Republic of China.

Zhaojiagou landfill is located at Shenyang city, the capital city of Liaoning province. It used to be far away from the urban area but now it is very close to the new edge of the city since the city is under fast development in the recent years. It was operated from 1998 to 2003 with a daily dumped waste volume of about 700 tonnes. In 2003 the landfill site was closed and covered with soil. The accumulated gross volume of buried and disposed waste in this landfill site reached a total amount of 1.53 million tonnes.

Gaoguanling landfill is located in Anshan city which is 89km away from Shenyang city. Similar as Zhaojiagou landfill site, Gaoguanling landfill site is now also close to the urban area of the city. It was closed and covered with soil in 2,000. During its operation period from 1985 to 2,000 an accumulated gross volume of 2.63 million tonnes of municipal waste was there deposited.

Langshan landfill is located in the sub area of Chaoyang city, 9.8 km away from the city. Chaoyang city is in the west part of Liaoning province. The landfill started operation in 1992 and it is still operating. It is expected that when it is closed by 2010 totally about 1.92 million tonnes of municipal waste will be deposited.

All these three landfills were constructed more than ten years ago. They are based on natural valley and the organic elements of the disposed municipal waste decays under anaerobic conditions. Due to the very limited concern as well as very limited budget, no landfill gas collection/destruction facility exists prior to this proposed project activity. At that time these landfills were quite far from the cities, however, with the fast growing economy and the fast expansion of these cities, the landfills are now very close to the newly constructed local residential area –actually less than 1 km. For Zhajiagou and Gaoguanling landfills which have been closed for years the nearby people are still suffering from the bad smell especially in summer or rainy days. For Langshan landfill which is not closed yet the local pollution is even much heavier. The local concern to environmental problems due to these landfill sites is becoming more and more significant.

As explained in section B4, the baseline scenario is the same as the existing scenario, i.e. atmospheric release of the landfill gas and hot water production by coal fired boilers. With the proposed project, the LFG generated in the involved landfills will be captured by newly constructed LFG collection and destructed. Most of the captured LFG will be utilized by the boilers system to produce thermal energy while a small part of LFG will be combusted in flare. Thus the project scenario is the collection and destruction of LFG, as well as thermal energy production.

The proposed project falls into the scope of the CDM priority areas presented in the Administrative Regulations of Clean Development Mechanism of China[1]: recycling and utilisation of methane. Besides, the proposed project has the following additional sustainable development benefits:

(1) Reduction of local environmental pollution. The proposed project activity includes the installation of boilers to produce hot water for municipal use replacing some existing coal-fired boilers. Thus it will directly reduce local air pollution from the burning of fossil fuels.

(2) Accelerating the uptake of landfill gas recovery and utilisation in China. The involved landfills represent typical medium-sized landfills in China. Projects to utilise landfill gas in China have not been economically viable in recent years and CDM presents a real investment opportunity for energy generation based on landfill gas sites. This project will be a good demonstration for other small/medium scale landfills in China, and as such, will contribute to the general body of knowledge for the sector on how to successfully manage and utilise landfill gas.

(3) Improvements to safety and the site environment. The project will reduce danger from fire or explosion on the landfill site by recovering the gas as well as decreasing the odours on site.

(4) The project will create employment opportunities for the local community during the construction and operation period.

(5) The project per se is a significant source of reduction of greenhouse gases and therefore contributes to the mitigation of adverse impacts of climate change, both locally and globally.

Summarily the proposed project activity will not only benefit the global reduction of greenhouse gas emissions, but also contribute much to the local environment and safety.

A.3. Project participants:

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[1] http://cdm.ccchina.gov.cn/web/NewsInfo.asp?NewsId=458

Name of Party involved (*) (host) indicates a host Party)	Private and/or public entity(ies) project participants(*) (as applicable)	Kindly indicate if the Party involved wishes to be considered as project participant (Yes/No)
People's Republic of China (Host)	Liaoning Kaitian Renewable&Environment Co., Ltd	No
The United Kingdom of Great Britain and Northern Ireland	Cantor Fitzgerald Europe	No

Further contact information of project participants is provided in Annex 1.

A.4. Technical description of the project activity:

A.4.1. Location of the project activity:

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, Anshan City and Chaoyang City

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

Three landfills are referred to in this project. They are all in Liaoning province. The detailed location information of these three landfills is as listed below, while the coordinates are given by local Environmental Protection Bureau:

- Zhaojiagou landfill site: Bakeshu Street, Qianjin Town, Dongling District, Shenyang city. The coordinates of the landfill site are: longitude 123º3'36''E and latitude 41º4'12''N.
- Gaoguanling landfill site: Gaoguanling Village, Tiedong District, Anshan city. The coordinates of the landfill site are: longitude 123º10'12''E and latitude 41º9'36''N.
- Langshan landfill site: Zhongshan Street, Chaoyang city. The coordinates of the landfill site are: longitude 120º27'36''E and latitude 41º36'36''N.

Figure 1: Project Geographical Location

Zhaojiagou Landfill

Gaoguanling Landfill

Langshan Landfill

Figure 2 - Pictures of the Landfill Sites

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

Sectoral scope 1: Energy industries (renewable - / non-renewable sources)
Sectoral scope 13: Waste handling and disposal

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

The proposed project activity consists of upgrading the existing landfill sites with a LFG recovery and utilization system, including LFG collection, pre-treatment, flaring, boilers, and monitoring equipment, data recording.

Gas collection system

At present, there is no gas venting wells. The proposed project will apply modern LFG collection system which will consist of newly installed branch pipes, head pipes, and extraction wells for effective collection of the LFG. The expected LFG capture efficiency is in the range of 50%~60% (50% for Langshan landfill, 60% for Zhaojiagou and Gaoguanling landfill).

Gas pre-treatment system

Prior to flaring or combustion in boilers, captured LFG must be pre-treated to remove its impurities and moisture and so on in order to prevent corrosion in the flaring and boiler system. The pre-treatment consists of the filtration of solid impurities and dewatering of moisture.

Boilers

In accordance to the expected landfill gas volume and methane concentration, the model of gas boilers has been selected as follows. The same model of boiler will be installed at all these three landfill sites:

Table 1: Boiler Specifications

Landfill Site	**Steam Boiler**	
Zhaojiagou Gaoguanling Langshan	Model	DZS2-0.7-Q
	Number of boilers	1
	Steam Capacity	2 t/h
	Operation Pressure	0.7MPa
	Saturated Steam Temperature	168℃

The steam boilers will be equipped with a steam-water heat exchanger unit.
All the boilers installed in the proposed project do not need fossil fuel for co-firing or start-up.

Flaring system

The LFG which is not used in the boilers will be flared. An enclosed auto-ignition flare platform will be installed in each of these three landfill sites. The specifications of the flare are as follows:

Table 2: Flare Specifications

Landfill Site	Model	AZFD-L
Zhaojiagou Gaoguanling Langshan	Number of flares	1
	Flowrate	$150m^3/h \sim 850m^3/h$
	Combustion temperature	≥850℃

Monitoring and protection system

The technology used in the project will be the state-of-the-art technology. High standard technology and monitoring equipment will be adopted, including monitoring, maintenance and calibration. Also, there is a safety system based on the continuous monitoring of the methane and oxygen concentration in the captured LFG. If the oxygen concentration is in the dangerous range, or the boiler is under fix/maintenance, the LFG will be fed to the flaring system instead of the boilers.

There is no technology transfer to the host party.

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

The project activity is envisaged to yield an average annual emission reductions equivalent to 63,467 tCO_2e, totalling 634,667 tCO_2e during the 10-year fixed crediting period. Estimated emission reductions for the 10-year fixed crediting period are presented in the following table.

Table 3: Emission Reductions from Project Activity

Crediting Year	**Annual estimation of Emission reductions in tonnes of CO2e**			
	Zhaojiagou	**Gaoguanling**	**Langshan**	**Total**
2009*	25,677	20,810	27,157	73,645
2010	25,745	20,892	29,484	76,121
2011	24,401	19,817	28,225	72,443
2012	23,129	18,798	26,869	68,796
2013	21,925	17,833	25,444	65,202
2014	20,784	16,918	24,097	61,800
2015	19,705	16,052	22,822	58,579
2016	18,682	15,231	21,616	55,530
2017	17,714	14,453	20,475	52,643
2018	16,797	13,716	19,395	49,908
Total estimated reductions (tonnes of CO2e)	214,561	174,521	245,585	634,667
Total number of crediting years	**10**	**10**	**10**	**10**
Annual average over the crediting period of estimated reductions (tonnes of CO2e)	21,456	17,452	24,559	63,467

*: Please note that it refers to a 12 months crediting year starting from the starting date of crediting period. It is the same case with the other row s in this table as well as some other tables in the following sections.

A.4.5. Public funding of the project activity:

No public funding from Annex I countries is involved in the proposed project.

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:

In this project the Version 09 of the *Consolidated baseline and monitoring methodology for landfill gas project activities* (ACM0001) and the following tools referred by the methodology are used:

- *Tool for demonstration and assessment of additionality (version 5.2)*
- *Tool to determine project emissions from flaring gases containing methane (version 01)*
- *Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site (version 04)*
- *Tool to calculate baseline, project and/or leakage emissions from electricity consumption (version 01)*
- *Tool to calculate project or leakage CO2 emissions from fossil fuel combustion (version 02)*

All the above methodologies are available at
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:

This methodology is applicable to landfill gas capture project activities, where the baseline scenario is the partial or total atmospheric release of the gas and the project activities include situations such as:

a) The captured gas is flared; and/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.

For the proposed project activity, there is no LFG capture prior to it and the captured gas is used to produce energy (thermal energy) as described in item (b), or be flared as described in item (a). Thus the project fully meets all the applicability criteria as set out in the methodology.

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

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The project boundary encompasses these three landfill sites, where the gas is captured and destroyed/utilized, and the transportation system which delivers the produced hot water to the end users. In addition, although there is no power generation, the proposed project will consume electricity during the daily operation, so the project boundary includes all the power plants connected to the North China Power Grid from which the project activity sources electricity.

Table 4: Summary of gases and sources included in the project boundary and justification / explanation where gases and sources are not included

	Source	Gas	Included?	Justification / Explanation
Baseline	Emissions from decomposition of waste at the landfill site	CH_4	Yes	The major source of emissions in the baseline
		N_2O	No	N_2O emissions are small compared to CH_4 emissions from landfills. Exclusion of this gas is conservative.
		CO_2	No	CO_2 emissions from the decomposition of organic waste are not accounted.
	Emissions from thermal energy generation	CO_2	Yes	thermal energy generation is included in the project activity
		N_2O	No	Excluded for simplification. This is conservative.
		CH_4	No	Excluded for simplification. This is conservative.
Project Activity	On-site fossil fuel consumption due to the project activity other than for electricity generation	CO_2	Yes	The boilers installed in the proposed project do not need fossil fuel for co-firing or start-up. But the transportation of hot water will lead to fossil fuel consumption.
		N_2O	No	Excluded for simplification. This emission source is assumed to be very small.
		CH_4	No	Excluded for simplification. This emission source is assumed to be very small.
	Emissions from on-site electricity use	CO_2	Yes	May be an important emission source since the operation of the project activity will lead to consumption of electricity imported from the grid.
		N_2O	No	Excluded for simplification. This emission source is assumed to be very small.
		CH_4	No	Excluded for simplification. This emission source is assumed to be very small.

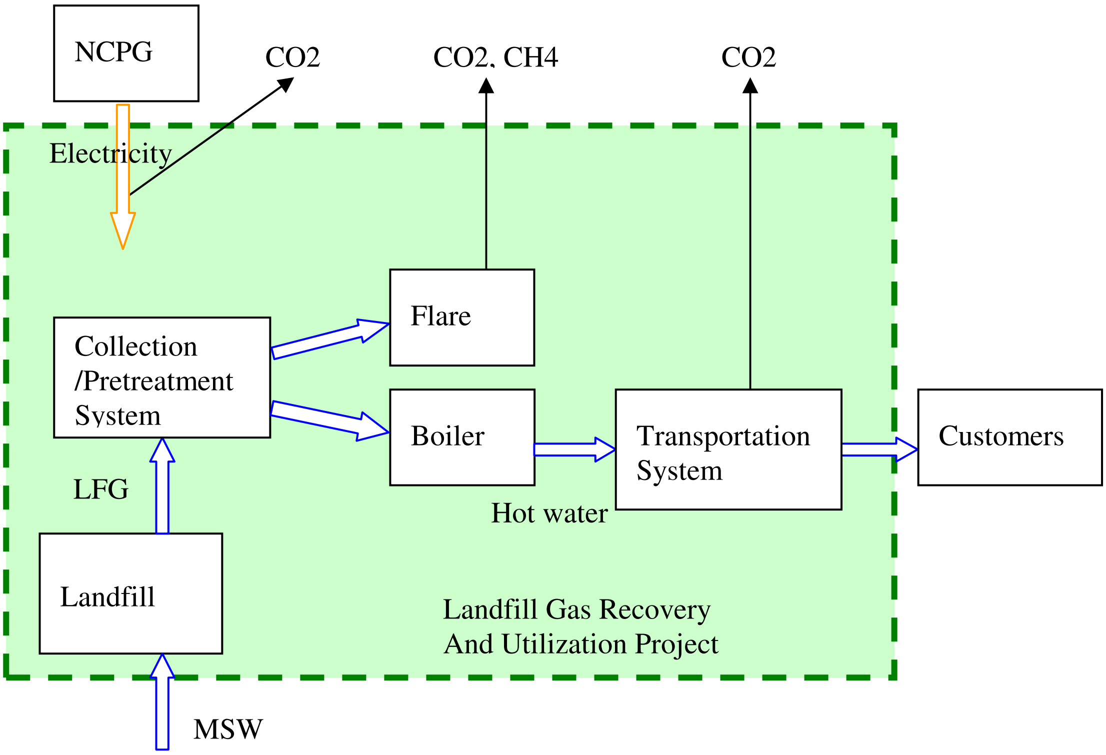

Figure 3: Project Boundary

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

According to the approved methodology ACM0001, the baseline scenario of the project activity is defined as the following procedures, using the "Tool for the demonstration and assessment of additionality" (version 5.2).

STEP 1: Identification of alternative scenarios

Sub-step 1a. Define alternatives to the project activity:

For the treatment of landfill gas in the absence of the project activity, the possible alternatives should include, inter alia:

LFG1. The project activity, capture of landfill gas and its flaring and use, undertaken without being registered as a CDM project activity;
LFG2. Atmospheric release of the landfill gas as before (business as usual).

Since the project activity also includes heat generation – the produced hot water will be used by nearby hotels/public baths, the possible alternatives for heat generation should also be separately determined as below:
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).

No electricity generation is included in the proposed project activities, so the alternatives of cogeneration, H2 and H3, are actually not a real alternative for the proposed project. Besides, according to the *Interim Measures for the Management of Development of Cogeneration and Coal Refuse Comprehensive Utilization for Power Generation Project*[2]*s* issued by NDRC and MOC in Feb 2007, cogeneration projects should be developed to meet the demand for central heating and in those areas where central heating is not possible cogeneration projects will not be approved. For the proposed project activity, the produced hot water will mainly be used by baths and hotels which are not the case of central heating and need hot water for the whole year rather than in the winter only. So H2 and H3 can be eliminated from the alternative list.

As explained in above paragraph, the proposed project activity will provide hot water in the whole year so as to fulfil the continuous needs of baths and hotels, so it should be a steady, reliable thermal energy generation system. Considerate the commercial renewable energy resources, solar water heating systems can not provide steady hot water since it depends on the weather; biomass residue is the most common fuel for renewable energy based boilers, but it should be noticed that until now there is no report on biomass based heat(only) generation project since it is not financially attractive. Actually even most of those biomass power generation projects which can enjoy the special electricity tariff are still financially unattractive and need the extra CDM revenue. And it can found that there is no previous report on the application of heat generation other kind of renewables, in project cities. So H5 is also eliminated from the alternative list.

It is technical viable to supply hot water to hotels and public baths via district heat system. Nevertheless, since the district heating system is mainly designed for residence heating in cold season, necessary adoptions in district heating system operation, heat exchange system, as well as the metering and accounting system are needed. Usually the utility is not interested in doing so. Especially in summer, it is obviously uneconomical to run the entire district heating system to provide hot water only for hotels and public baths while there is no other customer. So H6 is also eliminated from the alternative list.

Solar energy is widely used to produce hot water for home use. But for this proposed project, as explained in above paragraph, the proposed project activity will provide hot water in the whole year so as to fulfil the continuous needs of baths and hotels, so it should be a steady, reliable thermal energy generation system. It is obvious that solar water heating systems can not provide steady hot water since it entirely depends on the weather – surely the local residues also want to enjoy the public baths in rainy days. Pure solar water heating system is therefore not applicable here. On the other hand, the

[2] http://www.ndrc.gov.cn/zcfb/zcfbtz/2007tongzhi/t20070131_115017.htm

solar/electricity water heating system is not a good choice neither - producing big amount of hot water with electricity in rainy or cloudy days is obviously non profitable since the cost is far higher than coal fired boilers. It's the similar case with heat pump whose performance also depends on local resource and environment and needs auxiliary electricity to ensure the continuous and steady production of hot water. So H7 is also excluded from the realistic alternative list.

Sub-step 1b. Consistency with mandatory laws and regulations:

Currently in China there are regulations in place dealing with the management of landfills and landfill gas. The regulations relevant to the project include: *National Sanitary Landfill Emission Control Standard (GB16889-1997)* and *Chinese Technical Code for Sanitary Landfill of Municipal Domestic Refuse (CJJ17-2001).*

These regulations specify safety limits for methane concentration in the air and buildings around landfill sites and document the procedures of venting LFG to remove the gas from the site and disperse it safely into the atmosphere. They also require that LFG should be flared or where possible utilised. The most recent update of CJJ17-2001, i.e. the CJJ17-2004, re-emphasizes the responsibility of the landfill operator for the mandatory treatment of the LFG. Hence, according to the present policies, landfill operators should flare and where possible utilise LFG.

However, due to financial and technical difficulties these activities have not been widely practiced in China. In August 2005 a programme funded by UNDP and GEF also has the same findings[3]:

At present, in China the municipal refuse is disposed using the technology of traditional landfill, without consideration of recovery and utilization of landfill methane. It is estimated that the annual quantity of municipal refuse filled is about 50 million tons. Almost all landfills has not equipped the system of landfill gas recovery, except several new built landfills, and the landfill methane is emitted to the atmosphere openly.

Most recently, in Feb 2007, the China Ministry of Construction issued a report saying that after the inspection of 372 landfill sites in 31 provinces, cities and autonomous regions in China it was revealed that 92.76% of the landfills have no landfill gas recovery and utilisation facilities[4]. Especially for those old landfills which started operation since 1990s or even earlier, free emission of landfill gas is the common practise since the limited attention of local government has been paid to newly built landfills.

Therefore, despite attempts to mandate the flaring and treatment of landfill gas, they are not widely enforced and the common practice in China remains venting LFG.

Alternatives LFG1, LFG2, H1, and H4 are in compliance with the national laws and regulations. It should be noticed that "LFG1+H4" is not a reasonable option since if the LFG has been collected it is not a wise choice to simply flare it and burn fossil fuel to produce thermal energy. And obviously the

[3] Section 2.4, National Action Plan for Recovery and Utilization of Landfill Gas (Revised Edition)

[4] Notification of Inspection Outcome on China National Sanitary Landfill Site, Volume 1, 2007, Technology of Municipal Solid Waste Treatment

combination of “LFG2+H1” is not possible. So the possible alternatives can only be “LFG1+H1” and “LFG2+H4”.

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

Alternative H4 is a feasible baseline scenario. Currently the hot water used by the hotels and public baths comes from some coal fired boilers. According to the “Measures for Administration of municipal heat-supply of Liaoning Province”[5], the heat suppliers are encouraged to utilise clean and energy efficient technology but coal fired boilers are still popular in Liaoning province. The coal burned in the boilers is from different provinces and with various qualities. There is no complete and authoritative analysis data of these kinds of coal. But according to the common practice, they can be classified as ‘bituminous coal’.

STEP 3: Step 2 of the latest approved version of the Tool for demonstration and assessment of additionality shall be used to assess which of these alternatives should be excluded from further consideration.

Sub-step3a: Determine appropriate analysis method:
According to the *“Tool for the demonstration and assessment of additionality”* (version 5.2), there are three options for the execution of the investment analysis.

(I) Simple cost analysis (the CDM project activity generates no financial or economic benefits other than CDM related income)
(II) Investment comparison analysis (the relevant financial indicator (IRR, NPV) is determined and compared, or
(III) Benchmark analysis (the relevant financial indicator is compared to a benchmark)

The project will have proceeds from hot water sales as well as from emission reduction credits, therefore Option I is not applicable. Option II is not applicable either since there are no comparable investment alternatives at the proposed landfill sites available to the project proponent. The most appropriate financial analysis method is therefore option III: the benchmark analysis.

Sub-step3b: Option III - Apply benchmark analysis:

The IRR is selected as the relevant financial indicator for the project. Since thermal energy production projects are not of investment priority in China and there are not many newly developed thermal energy projects, it is difficult to identify a nationwide accepted benchmark IRR. One possible reference is the *“Economic Assessment Method and Parameters for Construction Project” (version 3)* issued jointly by NDRC and Ministry of Construction in 2006. It suggests a benchmark Equity IRR of 10% (after tax) for thermal energy projects. Another possible reference is the other landfill gas projects – almost all the other landfill gas projects in China include the component of power generation in their activities and refer to a benchmark IRR of 8% given by the *“Interim Rules on Economic Assessment of Electric Engineering Retrofit Project”* issued by the State Power Corporation of China in 2003. The *“Economic Assessment Method and Parameters for Construction Project” (version 3)* also indicates a benchmark

[5] http://www.ykgysy.gov.cn/view.asp?ID=63

Equity IRR (after tax) of 8% for LFG power generation project. For the purpose of conservativeness, the benchmark Equity IRR (after tax) of 8% is used for the financial analysis of the proposed project activity.

Sub-step3c: Calculation and comparison of financial indicators:

The IRR of the alternatives baseline scenarios LFG1&H1 is calculated, as described in section B5. The result shows that the Equity IRR of alternative baseline scenario 1 (LFG1, H1), the project activity not undertaken as CDM project, is negative and far lower than the benchmark, so it is not financially feasible because the IRR for this scenario is significantly lower than the identified benchmark. Therefore this scenario is not the baseline scenario.
Therefore, the alternative baseline scenario 2 (LFG2, H4), the continuation of the current practice of not extracting, and utilising or flaring the landfill gas and the thermal energy is generated by the existing or newly constructed fossil fuel based boilers, is the only realistic baseline scenario, as follows:

LFG2. Atmospheric release of the landfill gas.
H4. Existing or new construction of on-site or off-site fossil fuel based boilers.

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): >>

The incentive from the CDM had been seriously taken into account prior to the starting date of the project activity, aiming to obtain the additional funding to secure the project financially. The project was evaluated to be financially unattractive in the Feasibility Study Report (FSR), with an IRR lower than the benchmark if not registered as a CDM project. Therefore, the developer made the decision of applying for CDM registration and seeking for a CERs buyer before the start of the project.

Here is the defined timetable of the Proposed Project:

Table 5 Timetable of the Proposed Project

Event	Date		
	Zhaojiagou	Gaoguanling	Langshan
Feasibility Study Report Developed	Mar 2008	Jan 2008	Mar 2008
Brokerage and consulting agreement	Jan 11th, 2008 Brokerage and consulting agreement for Zhaojiagou and Gaoguanling projects May 25th, 2008, Supplemental Agreement to include Langshan Projects		
Purchase of Flare		Feb 20th, 2008	
LOI for Emission Reductions	Jun 5th, 2008		
Enterprise Investment Project Registration Certificate by local DRC	Jun 6th, 2008	Mar 26th, 2008	Jun 17th, 2008
EIA Approved by local Environmental Protection Bureau	Jun 18th, 2008	May 20th, 2008	Jun 2nd, 2008
Contract for Validation Service Signed	Sep, 2008		

LOA Issued	Sep 22nd, 2008		
Expected time to start equipment Pruchase and Construction	Oct 2008		Oct 2008
Expected time to start flaring of collected LFG	Mar 1st, 2009		
Expected time to start hot water production	Jun 2009		

So the date of the purchase contract for the flare of Gaoguanling Project, which is Feb 20th, 2008, is the starting date of the proposed project activities.

The following steps from the *"Tool for the demonstration and assessment of additionality"* (version 5.2) are taken to demonstrate the additionality of the project.

STEP 1: Identification of alternative scenarios

Sub-step 1a. Define alternatives to the project activity:

The proposed project activity includes the collection of LFG and the utilization of collected LFG – to produce thermal energy, so the possible alternatives including all possible combinations of LFG treatments and thermal energy production in the absence of the project activity.

For the treatment of landfill gas, the possible alternatives include:

LFG1. The project activity, capture of landfill gas and its flaring and use, undertaken without being registered as a CDM project activity;
LFG2. Atmospheric release of the landfill gas as before (business as usual scenario).

For thermal energy production, the possible alternatives for heat generation should also be separately determined as below:

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.
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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).

No electricity generation is included in the proposed project activities, so the alternatives of cogeneration, H2 and H3, are actually not a real alternative for the proposed project. Besides, according to the *Interim Measures for the Management of Development of Cogeneration and Coal Refuse Comprehensive Utilization for Power Generation Projecs* issued by NDRC and MOC in Feb 2007, cogeneration projects should be developed to meet the demand for central heating and in those areas where central heating is not possible cogeneration projects will not be approved. For the proposed project activity, the produced hot water will mainly be used by baths and hotels which are not the case of central heating and need hot water for the whole year rather than in the winter only. So H2 and H3 can be eliminated from the alternative list.

As explained in above paragraph, the proposed project activity will provide hot water in the whole year so as to fulfil the continuous needs of baths and hotels, so it should be a steady, reliable thermal energy generation system. Considerate the commercial renewable energy resources, solar water heating systems can not provide steady hot water since it depends on the weather; biomass residue is the most common fuel for renewable energy based boilers, but it should be noticed that until now there is no report on biomass based heat(only) generation project since it is not financially attractive. Actually even most of those biomass power generation projects which can enjoy the special electricity tariff are still financially unattractive and need the extra CDM revenue. And it can found that there is no previous report on the application of heat generation other kind of renewables, in project cities. So H5 is also eliminated from the alternative list.

It is technical viable to supply hot water to hotels and public baths via district heat system. Nevertheless, since the district heating system is mainly designed for residence heating in cold season, necessary adoptions in district heating system operation, heat exchange system, as well as the metering and accounting system are needed. Usually the utility is not interested in doing so. Especially in summer, it is obviously uneconomical to run the entire district heating system to provide hot water only for hotels and public baths while there is no other customer. So H6 is also eliminated from the alternative list.

Solar energy is widely used to produce hot water for home use. But for this proposed project, as explained in above paragraph, the proposed project activity will provide hot water in the whole year so as to fulfil the continuous needs of baths and hotels, so it should be a steady, reliable thermal energy generation system. It is obvious that solar water heating systems can not provide steady hot water since it entirely depends on the weather – surely the local residues also want to enjoy the public baths in rainy days. Pure solar water heating system is therefore not applicable here. On the other hand, the solar/electricity water heating system is not a good choice neither - producing big amount of hot water with electricity in rainy or cloudy days is obviously non profitable since the cost is far higher than coal fired boilers. It’s the similar case with heat pump whose performance also depends on local resource and environment and needs auxiliary electricity to ensure the continuous and steady production of hot water. So H7 is also excluded from the realistic alternative list.

Sub-step 1b. Consistency with mandatory laws and regulations:

Currently in China there are regulations in place dealing with the management of landfills and landfill gas. The regulations relevant to the project include: *National Sanitary Landfill Emission Control Standard (GB16889-1997)* and *Chinese Technical Code for Sanitary Landfill of Municipal Domestic Refuse (CJJ17-2001).*

These regulations specify safety limits for methane concentration in the air and buildings around landfill sites and document the procedures of venting LFG to remove the gas from the site and disperse it safely into the atmosphere. They also require that LFG should be flared or where possible utilised. The most recent update of CJJ17-2001, i.e. the CJJ17-2004, re-emphasizes the responsibility of the landfill operator for the mandatory treatment of the LFG. Hence, according to the present policies, landfill operators should flare and where possible utilise LFG.

However, due to financial and technical difficulties these activities have not been widely practiced in China. In August 2005 a programme funded by UNDP and GEF also has the same findings[6]:

At present, in China the municipal refuse is disposed using the technology of traditional landfill, without consideration of recovery and utilization of landfill methane. It is estimated that the annual quantity of municipal refuse filled is about 50 million tons. Almost all landfills has not equipped the system of landfill gas recovery, except several new built landfills, and the landfill methane is emitted to the atmosphere openly.

Most recently, in Feb 2007, the China Ministry of Construction issued a report saying that after the inspection of 372 landfill sites in 31 provinces, cities and autonomous regions in China it was revealed that 92.76% of the landfills have no landfill gas recovery and utilisation facilities[7]. Especially for those old landfills which started operation since 1990s or even earlier, free emission of landfill gas is the common practise since the limited attention of local government has been paid to newly built landfills.

It's also noted that recently Ministry of Environmental Protection issued the "Standard for Pollution Control on the Landfill Site of Municipal Solid Waste"(GB 16889 -2008), which is the updated version of GB16889-1997. Within the new standard which is effective sine 1 July 2008, some LFG related items are updated with more specific instructions while both versions has the same concern for the possible local environmental and safety impacts of LFG.

However, as explained before, the national standards have not been widely implemented in China due to the economic barriers. It's not likely that the updated standard will lead to significant changes.

Therefore, despite attempts to mandate the flaring and treatment of landfill gas, they are not widely enforced and the common practice in China remains venting LFG.

Alternatives LFG1, LFG2, H1, and H4 are in compliance with the national laws and regulations. It should be noticed that "LFG1+H4" is not a reasonable option since if the LFG has been collected it is not a wise choice to simply flare it and burn fossil fuel to produce thermal energy. And obviously the combination of "LFG2+H1" is not possible. So the possible alternatives can only be "LFG1+H1" and "LFG2+H4".

STEP 2: Investment analysis.

Sub-step2a: Determine appropriate analysis method:
According to the *"Tool for the demonstration and assessment of additionality"* (version 5.2), there are three options for the execution of the investment analysis.

(I) Simple cost analysis (the CDM project activity generates no financial or economic benefits other than CDM related income)

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[6] Section 2.4, National Action Plan for Recovery and Utilization of Landfill Gas (Revised Edition)

[7] Notification of Inspection Outcome on China National Sanitary Landfill Site, Volume 1, 2007, Technology of Municipal Solid Waste Treatment

(II) Investment comparison analysis (the relevant financial indicator (IRR, NPV) is determined and compared, or
(III) Benchmark analysis (the relevant financial indicator is compared to a benchmark)

The project will have proceeds from hot water sales as well as from emission reduction credits, therefore Option I is not applicable. Option II is not applicable either since there are no comparable investment alternatives at the proposed landfill sites available to the project proponent. The most appropriate financial analysis method is therefore option III: the benchmark analysis.

Sub-step2b: Option III - Apply benchmark analysis:

The IRR is selected as the relevant financial indicator for the project. Since thermal energy production projects are not of investment priority in China and there are not many newly developed thermal energy projects, it is difficult to identify a nationwide accepted benchmark IRR. One possible reference is the *"Economic Assessment Method and Parameters for Construction Project" (version 3)* issued jointly by NDRC and Ministry of Construction in 2006. It suggests a benchmark Equity IRR of 10% (after tax) for thermal energy projects. Another possible reference is the other landfill gas projects – almost all the other landfill gas projects in China include the component of power generation in their activities and refer to a benchmark IRR of 8% given by the *"Interim Rules on Economic Assessment of Electric Engineering Retrofit Project"* issued by the State Power Corporation of China in 2003. The *"Economic Assessment Method and Parameters for Construction Project" (version 3)* also indicates a benchmark Equity IRR (after tax) of 8% for LFG power generation project. For the purpose of conservativeness, the benchmark Equity IRR (after tax) of 8% is used for the financial analysis of the proposed project activity.

Sub-step2c: Calculation and comparison of financial indicators:

The Equity IRRs of the baseline scenario (without CDM revenue) and the proposed project activity with CDM revenue are calculated using the parameters listed in the following tables, for three projects respectively. These figures have been obtained from both the feasibility study of the proposed project activity and the calculation based on the methodology.

Table 6: Equity IRR analysis for Zhaojiagou

Item			Value	Source
Static investment	Total		14.0093 million RMB	FSR
	Construction		8.6898 million RMB	FSR
	Device/Equipment		2.8030 million RMB	FSR
	Preparation Fee		1.0377 million RMB	FSR
	Other Cost	Total	1.4788 million RMB	FSR
		Intangible Cost	0.4530 million RMB	FSR
		Other Intangible Cost	0.5259 million RMB	FSR
Free Cash			0.2128 million RMB	FSR
Project lifetime			15 years	FSR
Loan ratio			40%	FSR
Interest on loan			7.83%	FSR

Loan term		6 Years	FSR
Hot water price (incl.VAT)		24 RMB/tone	FSR
Cost of Hot Water Transportation		4 RMB/tone	FSR
Annual Hot Water Production		See Annex 3	FSR
Feed Water Purchase Price(including VAT)		2 RMB/tone	FSR
Electricity Price (including VAT)		0.83 RMB/kWh	NDRC Regulation[8]
Annual Electricity Consumption		374,200 kWh	FSR
Income Tax		25%	FSR
Value added tax for Hot Water		13%	National Regulation[9]
Value added tax for Feed Water		13%	FSR
City building tax		7%	FSR
Education tax		3%	FSR
Depreciation	Device/Equipment	Straight-line, 12 years, Residval value of 5%	FSR
	Buildings and Other Fixed Assets	Straight-line, 20 years, Residval value of 5%	FSR
	Intangible Assets	Straight-line, 10 years, Residval value of zero	FSR
	Other Intangible Assets	Straight-line, 5 years, Residval value of zero	FSR
CER price		9.0 €/tCO_2e	Assumed
Result			
Equity IRR without CER revenues		-16.37%	
Equity IRR with CER revenues		2.52%	

Table 7: Equity IRR analysis for Gaoguanling

Item		Value	Source
Static investment	Total	14.6789 million RMB	FSR
	Construction	8.9898 million RMB	FSR
	Device/Equipment	2.8230 million RMB	FSR
	Preparation Fee	1.0873 million RMB	FSR

[8] http://www.ndrc.gov.cn/zcfb/zcfbtz/2008tongzhi/t20080702_222224.htm

[9] http://www.gov.cn/banshi/2005-08/19/content_24733.htm

	Other Cost	Total	1.7788 million RMB	FSR
		Intangible Cost	0.4530 million RMB	FSR
		Other Intangible Cost	0.5259 million RMB	FSR
Free Cash			0.2107 million RMB	FSR
Project lifetime			15 years	FSR
Loan ratio			0%	FSR
Hot water price (incl.VAT)			24 RMB/tone	FSR
Cost of Hot Water Transportation			4 RMB/tone	FSR
Annual Hot Water Production			See Annex 3	FSR
Feed Water Purchase Price(including VAT)			2 RMB/tone	FSR
Electricity Price (including VAT)			0.83 RMB/kWh	NDRC Regulation[8]
Annual Electricity Consumption			374,200 kWh	FSR
Income Tax			25%	FSR
Value added tax for Hot Water			13%	National Regulation[9]
Value added tax for Feed Water			13%	FSR
City building tax			7%	FSR
Education tax			3%	FSR
Depreciation	Device/Equipment		Straight-line, 12 years, Residval value of 5%	FSR
	Buildings and Other Fixed Assets		Straight-line, 20 years, Residval value of 5%	FSR
	Intangible Assets		Straight-line, 10 years, Residval value of zero	FSR
	Other Intangible Assets		Straight-line, 5 years, Residval value of zero	FSR
CER price			9.0 €/tCO_2e	Assumed
Result				
Equity IRR without CER revenues			-19.19%	
Equity IRR with CER revenues			-4.12%	

Table 8: Equity IRR analysis for Langshan

Item		Value	Source
Static investment	Total	13.9877 million RMB	FSR
	Construction	8.6856 million RMB	FSR

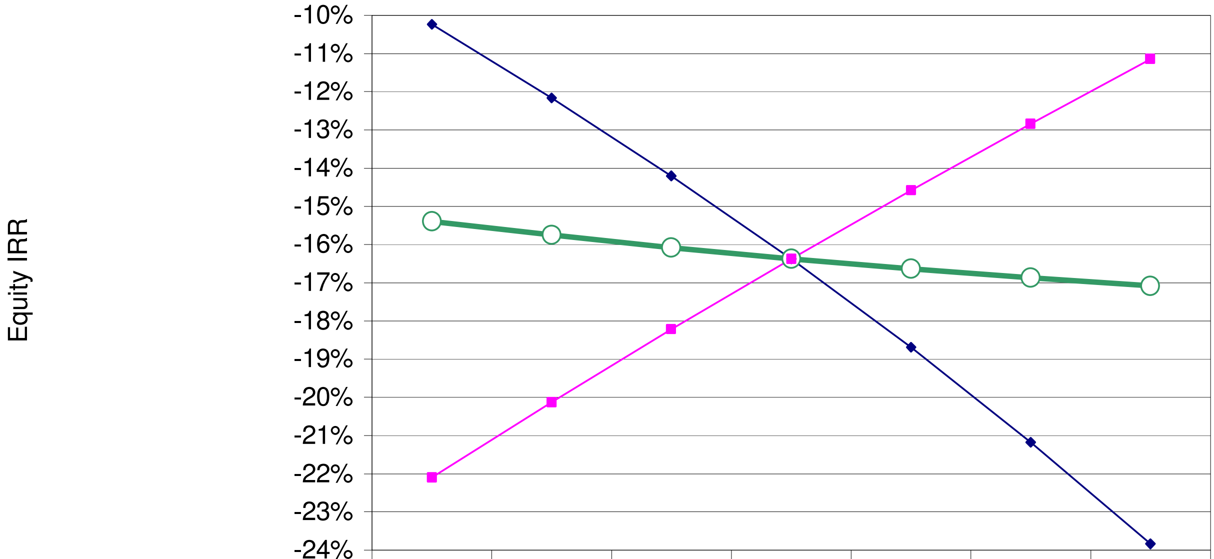
	Device/Equipment		3.1390 million RMB	FSR
	Preparation Fee		1.0361 million RMB	FSR
	Other Cost	Total	1.1270 million RMB	FSR
		Intangible Cost	0.0000 million RMB	FSR
		Other Intangible Cost	0.5270 million RMB	FSR
Free Cash			0.2113 million RMB	FSR
Project lifetime			15 years	FSR
Loan ratio			40%	FSR
Interest on loan			7.83%	FSR
Loan term			6 Years	FSR
Hot water price (incl.VAT)			24 RMB/tone	FSR
Cost of Hot Water Transportation			4 RMB/tone	FSR
Annual Hot Water Production			See Annex 3	FSR
Feed Water Purchase Price(including VAT)			2 RMB/tone	FSR
Electricity Price (including VAT)			0.83 RMB/kWh	NDRC Regulation[8]
Annual Electricity Consumption			374,200 kWh	FSR
Income Tax			25%	FSR
Value added tax for Hot Water			13%	National Regulation[9]
Value added tax for Feed Water			13%	FSR
City building tax			7%	FSR
Education tax			3%	FSR
Depreciation	Device/Equipment		Straight-line, 12 years, Residval value of 5%	FSR
	Buildings and Other Fixed Assets		Straight-line, 20 years, Residval value of 5%	FSR
	Intangible Assets		Straight-line, 10 years, Residval value of zero	FSR
	Other Intangible Assets		Straight-line, 5 years, Residval value of zero	FSR
CER price			9.0 €/tCO_2e	Assumed
Result				
Equity IRR without CER revenues			-13.04%	
Equity IRR with CER revenues			7.83%	

Based on the above analysis it can be concluded that for all these three projects, implementation of thte project without CDM revenue (baseline scenario LFG1+H1), is not financially feasible because the

Equity IRR is negative and far below the identified benchmark. Therefore they would not be financially attractive and would not be developed in the absence of CDM. The CER revenues will increase the IRR of the project activity and make the project more attractive to invest in.

Sub-step 2d. Sensitivity analysis

A sensitivity analysis was conducted by altering the key parameters including total static investment, price of hot water and annual operation & maintenance costs by ±15% and by assessing what the impact on the Equity IRR would the changes imply. These parameters were selected as being most likely to vary over time. The conducted sensitivity analysis is shown in the figure below.



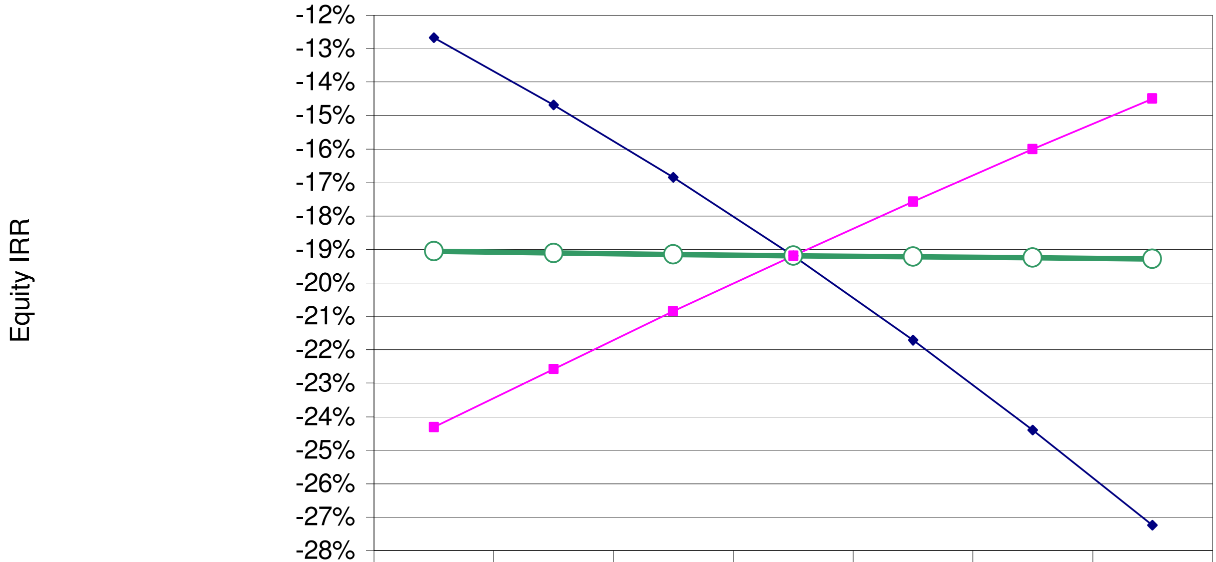
	-15.0%	-10.0%	-5.0%	0.0%	5.0%	10.0%	15.0%
Total Static Investment	-15.39%	-15.75%	-16.08%	-16.37%	-16.63%	-16.87%	-17.08%
Annual O&M Cost	-10.24%	-12.16%	-14.20%	-16.37%	-18.69%	-21.18%	-23.83%
Price of Hot Water	-22.10%	-20.13%	-18.22%	-16.37%	-14.58%	-12.84%	-11.15%

Deviation

Figure 4 Sensitivity analysis of Zhaojiagou Project

As shown in the above figure, the Equity IRR of Zhaojiagou project is mainly impacted by variations in the price of hot water and annual O&M cost. The impact of total static investment on Equity IRR is less significant. The sensitivity analysis shows that without CER revenue, the Equity IRR of the project is far lower than the benchmark 8% even if the annual O&M cost decreases by about 15% or the price of hot water increases by 15%.

Actually it can be determined that only if the total static investment decreases by 80.3%, or the annual O&M cost decreases by 86.3%, or the price of hot water increases by 91.6%, the Equity IRR of Zhaojiagou will reach the benchmark of 8%. But neither of the above is likely to happen.



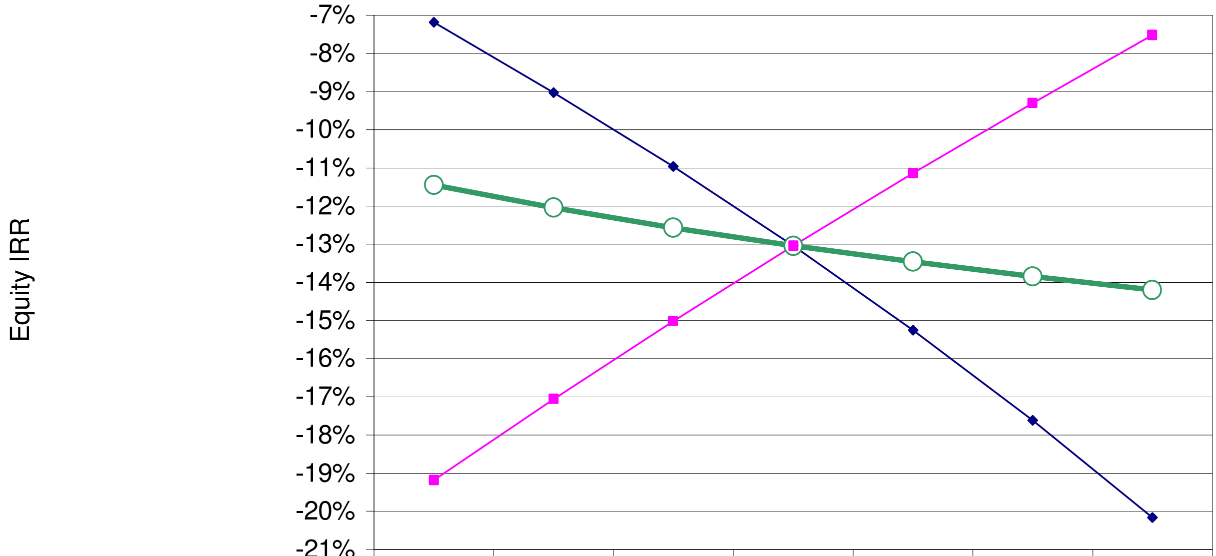
	-15.0%	-10.0%	-5.0%	0.0%	5.0%	10.0%	15.0%
Total Static Investment	-19.06%	-19.11%	-19.15%	-19.19%	-19.22%	-19.25%	-19.28%
Annual O&M Cost	-12.68%	-14.68%	-16.84%	-19.19%	-21.71%	-24.40%	-27.24%
Price of Hot Water	-24.32%	-22.57%	-20.85%	-19.19%	-17.57%	-16.00%	-14.49%

Deviation

Figure 5 Sensitivity analysis of Gaoguanling Project

As shown in the above figure, the Equity IRR of Gaoguanling project is mainly impacted by variations in the price of hot water and annual O&M cost. The impact of total static investment on Equity IRR is less significant. The sensitivity analysis shows that without CER revenue, the Equity IRR of the project is far lower than the benchmark 8% even if the annual O&M cost decreases by about 15% or the price of hot water increases by 15%.

Actually it can be determined that even if the total static investment decreases by 80%, the Equity IRR of Gaoguanling is still negative; when the annual O&M cost decreases by 80%, the Equity IRR of Gaoguanling can only reach 3.68%. Only if the price of hot water increases by 136%, the Equity IRR of Gaoguanling will reach the benchmark of 8%.



	-15.0%	-10.0%	-5.0%	0.0%	5.0%	10.0%	15.0%
Total Static Investment	-11.45%	-12.04%	-12.57%	-13.04%	-13.46%	-13.85%	-14.20%
Annual O&M Cost	-7.19%	-9.03%	-10.97%	-13.04%	-15.25%	-17.61%	-20.16%
Price of Hot Water	-19.18%	-17.06%	-15.01%	-13.04%	-11.14%	-9.30%	-7.52%

Deviation

Figure 6 Sensitivity analysis of Langshan Project

As shown in the above figure, the Equity IRR of Langshan project is mainly impacted by variations in the price of hot water and annual O&M cost. The impact of total static investment on Equity IRR is less significant. The sensitivity analysis shows that without CER revenue, the Equity IRR of the project is far lower than the benchmark 8% even if the annual O&M cost decreases by about 15% or the price of hot water increases by 15%.

Actually it can be determined that only if the total static investment decreases by 72.6%, or the annual O&M cost decreases by 75.5%, or the price of hot water increases by 74.3%, the Equity IRR of Langshan will reach the benchmark of 8%. But neither of the above is likely to happen.

Therefore, it can be safely concluded that for all these three projects, the Equity IRR is unlikely to reach the benchmark level with the three key factors varying in the normal range. This further underpins the outcome of the above investment analysis that the proposed project, without CDM revenues, is unlikely to be financially attractive.

Step3: Barrier analysis

This step is not applied

Step 4: Common practice analysis

Sub-step 4a: Analyze other activities similar to the proposed project activity

In 2007 the China Ministry of Construction inspected 372 landfill sites in 31 provinces, cities and autonomous regions in China and it revealed that 92.76% of the landfills have no landfill gas recovery and utilisation facilities. The report is in compliance with another earlier report which confirmed that almost all landfills have not implemented landfill gas recovery systems, except a few newly built landfills, and therefore the landfill gas is emitted to the atmosphere.

For the proposed LFG collection and thermal energy production project, the similar activities including those LFG collection and destruction (for power generation, thermal energy production or simply flared) projects, and as reported in a recent article[10], the only LFG collection and destruction project in Liaoning province is listed in the following table. Please note that as instructed by *"Tool for the demonstration and assessment of additionality"* (version 5.2), other CDM project activities (registered project activities and project activities which have been published on the UNFCCC website for global stakeholder consultation as part of the validation process) are not included in this analysis.

Table 9: Similar landfill sites in Liaoning province properties

Landfill	City	Waste Disposal Amount (metric tons per day)	Current Status
Yangeryu landfill	Anshan City	1200	LFG to vehicle fuel project funded by World Bank

Yangeryu LFG to vehicle fuel project was funded by World Bank which doesn't provide further fund to other projects.

Sub-step 4b. Discuss any similar options that are occurring:

As mentioned above, LFG generated from most landfills in China is directly emitted to the atmosphere. There are no gas capture and utilization facilities installed on-site. Directly emission of LFG is the common practice in China. Therefore, the proposed project is not common practice.

The existence of the above identified project that is similar to the proposed project activity does not contradict the claim in step 2 that the proposed project activity is financially unattractive. The Yangeryu landfill project was financially supported by World Bank. This is kind of benefit that is not prevalently accessible to most landfill projects. Step 4 is therefore passed.

Based on aforementioned steps, it can be safely concluded that the proposed project activity is additional.

B.6. Emission reductions:

B.6.1. Explanation of methodological choices:

The emission reductions resulting from the capture and combustion from methane are calculated in accordance with ACM0001 "Consolidated baseline methodology for landfill gas project activities" Version 09.

[10] Survey and Countermeasure for the Hazard-free Treatment of Domestic Waste Landfill in Liaoning Province, Chen Jun, Environmental Sanitation Engineering, Vol.15 No.5, October 2007

Baseline emissions
The baseline emissions are calculated as follows:

$$BE_y = (MD_{project,y} - MD_{BL,y}) \cdot GWP_{CH4} + EL_{LFG,y} \cdot CEF_{elec,BL,y} + ET_{LFG,y} \cdot CEF_{ther,BL,y} \quad (1)$$

Where:

BE_y	Baseline emissions in year y (tCO_2e)
$MD_{project,y}$	The amount of methane that would have been destroyed/combusted during the year, in tonnes of methane (tCH_4) in project scenario
$MD_{BL,y}$	The amount of methane that would have been destroyed/combusted during the year in the absence of the project due to regulatory and/or contractual requirement, in tonnes of methane (tCH_4)
GWP_{CH4}	Global Warming Potential value for methane for the first commitment period is 21 tCO_2e/tCH_4e
$EL_{LFG,y}$	Net quantity of electricity produced using LFG, 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)
$CEF_{elecy,BL,y}$	CO_2 emissions intensity of the baseline source of electricity displaced, in tCO_2e/ MWh
$ET_{LFG,y}$	The 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 in TJ
$CEF_{ther,BL,y}$	CO_2 emissions intensity of the fuel used by boiler to generate thermal energy which is displaced by LFG based thermal energy generation, in tCO_2e/TJ

The amount of methane that would have been destroyed/ combusted during the year y in the absence of the project due to regulatory and/or contractual requirements is calculated as follows:

$$MD_{BL,y} = MD_{project,y} \cdot AF \quad (2)$$

Where:
AF: Adjustment Factor

ACM0001 provides the guidance on how to estimate AF. AF should be considered in cases where a specific system for collection and destruction of methane is mandated by regulatory or contractual requirements or is undertaken for other reasons, the ratio of the destruction efficiency of the baseline system to the destruction efficiency of the system used in the project activity shall be used. For the proposed project, there is no contractual requirement. As explained before despite attempts to mandate the flaring and treatment of landfill gas, they are not widely enforced and the common practice in China remains venting LFG. Therefore, AF is zero.

The amount of methane that would have been destroyed/combusted during year y is calculated as follows since there is no power generation activity with the proposed project:

$$MD_{project,y} = MD_{flared,y} + MD_{thermal,y} \quad (3)$$

The amount of methane destroyed/combusted by flaring is calculated as:

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

Where:

$LFG_{flare,y}$	Quantity of LFG fed to the flare during year y measured in cubic meters (m^3)
w_{CH4}	Average methane fraction of the LFG as measured during year y and expressed as a fraction (in m^3CH_4 /m^3LFG)
D_{CH4}	Methane density expressed in tonnes of methane per cubic meter of methane (tCH_4/ m^3CH_4)
$PE_{flare,y}$	Project emissions from flaring of the residual gas stream in year y (tCO2e) determined following the procedure described in the "Tool to determine project emissions from flaring gases containing methane"

Determination of $PE_{flare,y}$:

The proposed project will install an enclosed flaring system. According to *"Tool to determine project emissions from flaring gases containing methane"*, option (a) for enclosed flares is selected to determine the flare efficiency.

(a) To use a 90% default value. Continuous monitoring of compliance with manufacturer's specification of flare (temperature, flow rate of residual gas at the inlet of the flare) must be performed. If in a specific hour any of the parameters are out of the limit of manufacturer's specifications, a 50% default value for the flare efficiency should be used for the calculations for this specific hour.

So $PE_{flare,y}$ is calculated as follows:

$$PE_{flare,y} = \sum_{h=1}^{8760} TM_{RG,h} \cdot \left(1-\eta_{flare,h}\right) \cdot \frac{GWP_{CH4}}{1000} \quad (5)$$

Where:

$TM_{RG,h}$	Mass flow rate of methane in the residual gas in the hour h
$\eta_{flare,h}$	Flare efficiency in hour h

The amount of methane destroyed/combusted by the boiler producing thermal energy is calculated as:

$$MD_{thermal,y} = (LFG_{thermal,y} \cdot w_{CH4,y} \cdot D_{CH4}) \quad (6)$$

Where:

$LFG_{thermal,y}$ is the quantity of landfill gas fed into the boiler.

Ex-ante estimation of the amount of methane that would have been destroyed/combusted during the year, in tonnes of methane

The ex-ante estimation of the amount of methane that would have been destroyed/combusted during the year, in tonnes of methane, will be done with the latest version of the approved "Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site", considering the LFG collection efficiency - it is estimated that only 50%~60% of the LFG generated in the landfill can be captured by the proposed project due to the technical constrains, as explained in Annex 3:

$$MD_{captured,y} = BE_{CH4,SWDS,y} \cdot FE_{collection} / GWP_{CH4} \quad (7)$$

Where:
$MD_{captured,y}$ is the total amount of methane captured in year y, in tones

$FE_{collection}$ is the overall LFG collection efficiency of the proposed project activity in year y
$BE_{CH4,SWDS,y}$ is the methane generation from the landfill in the absence of the project activity at year y (tCO_2e), calculated as per the "Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site" (version 02), as follows:

$$BE_{CH4,SWDS,y} = \varphi \cdot (1-f) \cdot GWP_{CH4} \cdot (1-OX) \cdot \frac{16}{12} \cdot F \cdot DOC_f \cdot MCF \cdot \sum_{x=1}^{y} \sum_{j} W_{j,x} \cdot DOC_j \cdot e^{-k_j \cdot (y-x)} \cdot (1-e^{-k_j}) \quad (8)$$

Where:

φ	Model correction factor to account for model uncertainties
f	Fraction of methane captured at the SWDS and flared, combusted or used in another manner
OX	Oxidation factor (reflecting the amount of methane from SWDS that is oxidised in the soil or other material covering the waste)
F	Fraction of methane in the SWDS gas (volume fraction)
DOC_f	Fraction of degradable organic carbon (DOC) that can decompose
MCF	Methane correction factor
$W_{j,x}$	Amount of organic waste type j prevented from disposal in the SWDS in the year x
DOC_j	Fraction of degradable organic carbon (by weight) in the waste type j
k_j	Decay rate for the waste type j
j	Waste type category (index)
x	Year during the crediting period: x runs from the first year of the first crediting period (x = 1) to the year y for which avoided emissions are calculated (x = y)
y	Year for which methane emissions are calculated

And the total volume of captured LFG can be determined then using the following formula:

$$LFG_{captured,y} = MD_{captured,y} \Big/ (w_{CH4,y} \cdot D_{CH4}) \quad (9)$$

The amount of LFG fed to the boiler ($LFG_{thermal,y}$) depends on the operation hour of the boiler as well as the LFG consumption per hour, taking into account that maybe there is not enough LFG for the full operation of the boiler. Then $MD_{thermal,y}$ can be determined using formula (6).

According to the system design, all the LFG which is not utilized in the boiler will be fed to the flare. And in the ex-ante estimation it is assumed that the enclosed flare will operate well so the default methane destruction efficiency of 90% can be used. So:

$$LFG_{flare,y} = LFG_{captured,y} - LFG_{thermal,y} \quad (10)$$

And:

$$MD_{flare,y} = LFG_{flare,y} \cdot w_{CH4,y} \cdot D_{CH4} \cdot 90\% \quad (11)$$

Determination of $ET_{LFG,y}$

The proposed project will provide hot water to users.

For hot water production, $ET_{LFG,y}$ can be determined as difference of the accumulative enthalpy of hot water and feed water:

$$ET_{LFG,y} = \int_t H_{hotwater} \cdot F_{hotwater} - \int_t H_{feedwater} \cdot F_{feedwater} \quad (12)$$

Where:

$H_{hotwater}$ the enthalpy of output hot water, in TJ/tone;
$H_{feedwater}$ the enthalpy of feed water, in TJ/tone;
$F_{hotwater}$ the mass flow rate of output hot water, in tones;
$F_{feedwater}$ the mass flow rate of feed water, in tones;

And since in the actual practice, the hot water is transported by trucks, and water can be treated as non-compressible, $ET_{LFG,y}$ can be determined as follows:

$$ET_{LFG,y} = M_{hotwater} \cdot C_{water} \cdot (T_{avg,hotwaer} - T_{avg,feedwater}) \quad (13)$$

Where:

$M_{hotwater}$ the total quantity of hot water supplied by the project activity during the year y in tonnes;
C_{water} the specific heat capacity of water, 0.0000042 TJ/(tone • ℃)
$T_{avg,hotwater}$ the average temperature of hot water which has been delivered to end users, in ℃;
$T_{avg,feedwater}$ the average temperature of fed water to the boiler, in ℃;

Determination of $CEF_{ther,BL,y}$

$$CEF_{ther,BL,y} = \frac{EF_{coal,BL}}{\varepsilon_{boiler} \cdot NCV_{coal,BL}} \quad (14)$$

Where:

ε_{boiler}	The energy efficiency of the boiler used in the absence of the project activity to generate the thermal energy
$NCV_{coal,BL}$	Net calorific value of fuel, as identified through the baseline identification procedure, used in the boiler to generate the thermal energy in the absence of the project activity in TJ per unit of volume or mass
$EF_{coal,BL}$	Emission factor of the fuel, as identified through the baseline identification procedure, used in the boiler to generate the thermal energy in the absence of the project activity in tCO2 / unit of volume or mass of the fuel.

Project Emission

The equation for Project Emissions is stated as following:

$$PE_y = PE_{EC,y} + PE_{FC,j,y} \quad (15)$$

Where:

$PE_{EC,y}$	Emissions from consumption of electricity in the project case. The project emissions from electricity consumption will be calculated following the "Tool to calculate project emissions from electricity consumption" (version 01).
$PE_{FC,j,y}$	Emissions from consumption of heat in the project case. The project emissions from fossil fuel combustion will be calculated following the "Tool to calculate project or leakage CO2 emissions from fossil fuel combustion" (version 01). For this purpose, the processes j in the tool corresponds to all fossil fuel combustion in the landfill, as well as any other on-site fuel combustion for the purposes of the project activity. If in the baseline part of a LFG was captured then the heat quantity used in calculation is fossil fuel used in project activity net of that consumed in the baseline.

Determination of $PE_{EC,y}$

$PE_{EC,y}$ will be calculated following the *"Tool to calculate baseline, project and/or leakage emissions from electricity consumption"* (version 01). The tool provides procedures to calculate project emissions from electricity consumption for three different cases. For this proposed project, the electricity will be sourced from local power grid which is a part of Northeast China Power Grid. So Scenario A, Electricity consumption from the grid, was identified as the approach to follow:

Project emissions from consumption of electricity from the grid are calculated based on the power consumed by the project activity and the emission factor of the grid, adjusted for transmission losses, using the following formula:

$$PE_{EC,y} = EC_{PJ,y} \cdot EF_{grid,y} \cdot (1 + TDL_y) \qquad (16)$$

Where:

$EC_{PJ,y}$	the quantity of electricity consumed by the project activity during the year y (MWh)
$EF_{grid,y}$	the emission factor for the grid in year y (tCO_2e/MWh)
TDL_y	the average technical transmission and distribution losses in the grid in year y for the voltage level at which electricity is obtained from the grid at the project site

For the determination of $EF_{grid,y}$, Option A2 is chosen as:

A value of 1.3 tCO2e/MWh if:

(a) Scenario A applies only to project and/or leakage electricity consumption sources but not to baseline electricity consumption sources;

So: $EF_{grid,y}$ =1.3 tCO2e/MWh

Determination of $PE_{FC,j,y}$

As above mentioned, the boilers installed in the proposed project do not need fossil fuel for co-firing or start-up. But the transportation of produced hot water to the customers will lead to additional fossil fuel consumption by trucks. According to the methodology, the project emissions from fossil fuel combustion should be calculated following the *"Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion"* (Version 02).

$$PE_{FC,j,y} = FC_{diesel,y} \cdot COEF_{diesel,y} \qquad (17)$$

Where:

$FC_{diesel,y}$	the quantity of diesel combusted during the year y
$COEF_{diesel,y}$	the CO_2 emission coefficient of diesel during the year y

Leakage

No leakage effects need to be accounted under this methodology.

Emission Reduction

Emission reductions are calculated as follows:

$$ER_y = BE_y - PE_y \tag{18}$$

Where:

ER_y	Emission reductions in year y (tCO_2e/yr)
BE_y	Baseline emissions in year y (tCO_2e/yr)
PE_y	Project emissions in year y (tCO_2e/yr)

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

Data / Parameter:	**GWP_{CH4}**
Data unit:	tCO_2e/tCH_4
Description:	Global warming potential of CH_4
Source of data used:	2006 IPCC Guidelines for National Greenhouse Gas Inventories
Value applied:	21
Justification of the choice of data or description of measurement methods and procedures actually applied :	21 for the first commitment period.
Any comment:	

Data / Parameter:	**DCH_4**
Data unit:	tCH_4/m^3CH_4
Description:	Methane Density
Source of data used:	The methodology
Value applied:	See Annex 3
Justification of the choice of data or description of measurement methods	At standard temperature and pressure (0 degree Celsius and 1,013 bar) the density of methane is 0.0007168 tCH_4/m^3CH_4

and procedures actually applied :	
Any comment:	

Data / Parameter:	**$BE_{CH4,SWDS,y}$**
Data unit:	tCO_2e
Description:	Methane generation from the landfill in the absence of the project activity at year y
Source of data used:	Calculated as per the *"Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site"*.
Value applied:	See Annex 3
Justification of the choice of data or description of measurement methods and procedures actually applied :	As per the *"Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site"*.
Any comment:	Used for ex-ante estimation of the amount of methane that would have been destroyed/combusted during the year

Data / Parameter:	**TDL_y**
Data unit:	%
Description:	Average technical transmission and distribution losses in the ECPG in year y for the voltage level at which electricity is obtained from the grid at the project site
Source of data used:	Tool to calculate project emissions from electricity consumption
Value applied:	20%
Justification of the choice of data or description of measurement methods and procedures actually applied :	Use a default value of 20%
Any comment:	

Data / Parameter:	AF
Data unit:	-
Description:	Adjustment Factor
Source of data used:	Project Participants
Value applied:	0
Justification of the choice of data or description of measurement methods and procedures	

actually applied :	
Any comment:	

Data / Parameter:	ε_{boiler}
Data unit:	%
Description:	The energy efficiency of the boiler used in the absence of the project activity to generate the thermal energy
Source of data used:	The methodology
Value applied:	100%
Justification of the choice of data or description of measurement methods and procedures actually applied :	Option B for the determination of boiler efficiency is adapted as a conservative estimation.
Any comment:	

Data / Parameter:	$EF_{grid,y}$
Data unit:	tCO2e/MWh
Description:	the emission factor for the grid in year y
Source of data used:	Calculated as per the *“Tool to calculate baseline, project and/or leakage emissions from electricity consumption”*
Value applied:	1.3
Justification of the choice of data or description of measurement methods and procedures actually applied :	According to the *“Tool to calculate baseline, project and/or leakage emissions from electricity consumption”*, Option A2 of determination of the emission factor for the grid is chosen.
Any comment:	

Data / Parameter:	$\mathbf{C_{water}}$
Data unit:	TJ/(tone • ℃)
Description:	the specific heat capacity of water
Source of data used:	
Value applied:	0.00000418
Justification of the choice of data or description of measurement methods and procedures actually applied :	
Any comment:	

Data / Parameter:	**$NCV_{coal, BL}$**
Data unit:	TJ/Gg
Description:	the CO_2 emission factor per coal
Source of data used:	2006 IPCC Guidelines for National Greenhouse Gas Inventories
Value applied:	30.5
Justification of the choice of data or description of measurement methods and procedures actually applied :	In 2006 IPCC Guidelines for National Greenhouse Gas Inventories the coal was classified into coking coal, other bituminous coal and sub-bituminous coal. It can be confirmed that coking coal will not be used for local thermal power generation, so with this PDD, to be conservative, the highest NCV for the other two kind of coal, which is 30.5 TJ/Gg, is chosen.
Any comment:	

Data / Parameter:	**$EF_{coal, BL}$**
Data unit:	tCO_2/Gg
Description:	the CO_2 emission factor in tCO2 / unit of volume or mass of coal
Source of data used:	Calculated based on 2006 IPCC Guidelines for National Greenhouse Gas Inventories
Value applied:	2,729.75
Justification of the choice of data or description of measurement methods and procedures actually applied :	See Annex 3
Any comment:	

Data / Parameter:	$COEF_{diesel,y}$
Data unit:	-
Description:	the CO_2 emission coefficient of diesel during the year y
Source of data used:	Calculated as per the *"Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion"*
Value applied:	See Annex 3
Justification of the choice of data or description of measurement methods and procedures actually applied :	According to the *"Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion"*, Option B of determination of $COEF_{diesel,y}$ is chosen due to the lack of data to perform Option A.
Any comment:	The calculation is based on "2006 IPCC Guidelines for National Greenhouse Gas Inventories" and the result is given in Annex 3

Data / Parameter:	**Quantity of disposed municipal solid waste**
Data unit:	Tones/year
Description:	Quantity of disposed municipal solid waste in each of these three landfills during

	their life time
Source of data used:	Records from landfill operator
Value applied:	See Annex 3
Justification of the choice of data or description of measurement methods and procedures actually applied :	The data before 2008 are recorded by each landfill operator on the basis of daily receipt of the solid waste; data from 2008 till 2010 are assumptions according to the design plans and the city planning.
Any comment:	

Data / Parameter:	**Weight fraction of the waste type *j* in the disposed MSW**
Data unit:	%
Description:	Weight fraction of the waste type *j* in the disposed MSW
Source of data used:	Records from landfill operator
Value applied:	See Annex 3
Justification of the choice of data or description of measurement methods and procedures actually applied :	The data is provided by the landfill operators based on their internal or external check of the fraction of the waste.
Any comment:	

Data / Parameter:	φ
Data unit:	---
Description:	Model correction factor to account for model uncertainties
Source of data used:	As per the "Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site".
Value applied:	0.9
Justification of the choice of data or description of measurement methods and procedures actually applied :	Oonk et el. (1994) have validated several landfill gas models based on 17 realized landfill gas projects. The mean relative error of multi-phase models was assessed to be 18%. Given the uncertainties associated with the model and in order to estimate emission reductions in a conservative manner, a discount of 10% is applied to the model results.
Any comment:	

Data / Parameter:	OX
Data unit:	---
Description:	Oxidation factor (reflecting the amount of methane from SWDS that is oxidized in the soil or other material covering the waste)
Source of data used:	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value applied:	0.1
Justification of the	As per the "Tool to determine methane emissions avoided from disposal of

choice of data or description of measurement methods and procedures actually applied :	waste at a solid waste disposal site", Use 0.1 for managed solid waste disposal sites that are covered with oxidizing material such as soil or compost, which is the case of the proposed landfill sites.
Any comment:	

Data / Parameter:	**F**
Data unit:	---
Description:	Fraction of methane in the SWDS gas (volume fraction)
Source of data used:	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value applied:	0.5
Justification of the choice of data or description of measurement methods and procedures actually applied :	This factor reflects the fact that some degradable organic carbon does not degrade, or degrades very slowly, under anaerobic conditions in the SWDS. A default value of 0.5 is recommended by IPCC.
Any comment:	

Data / Parameter:	**DOC_f**
Data unit:	---
Description:	Fraction of degradable organic carbon (DOC) that can decompose
Source of data used:	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value applied:	0.5
Justification of the choice of data or description of measurement methods and procedures actually applied :	As per the "Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site".
Any comment:	

Data / Parameter:	**MCF**
Data unit:	---
Description:	Methane correction factor
Source of data used:	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value applied:	1.0
Justification of the choice of data or description of measurement methods and procedures actually applied :	Value of 1.0 for anaerobic managed solid waste disposal sites. These must have controlled placement of waste (i.e., waste directed to specific deposition areas, a degree of control of scavenging and a degree of control of fires) and will include at least one of the following: (i) cover material; (ii) mechanical compacting; or (iii) leveling of the waste. The conditions on the proposed landfills are in line with above criteria.

Any comment:	

Data / Parameter:	**DOC_j**
Data unit:	---
Description:	Fraction of degradable organic carbon (by weight) in the waste type j
Source of data used:	IPCC 2006 Guidelines for National Greenhouse Gas Inventories (adapted from Volume 5, Tables 2.4 and 2.5)
Value applied:	<table><tr><td>Waste type j</td><td>DOC_j (% wet waste)</td></tr><tr><td>Wood and wood products</td><td>43</td></tr><tr><td>Pulp, paper and cardboard (other than sludge)</td><td>40</td></tr><tr><td>Food, food waste, beverages and tobacco (other than sludge)</td><td>15</td></tr><tr><td>Textiles</td><td>24</td></tr><tr><td>Garden, yard and park waste</td><td>20</td></tr><tr><td>Glass, plastic, metal, other inert waste</td><td>0</td></tr></table>
Justification of the choice of data or description of measurement methods and procedures actually applied :	All the data – the total amount and the fraction are based on wet waste so DOC_j (% wet waste) is chosen.
Any comment:	

Data / Parameter:	**k_j**
Data unit:	
Description:	Decay rate for the waste type *j*
Source of data used:	IPCC 2006 Guidelines for National Greenhouse Gas Inventories (adapted from Volume 5, Table 3.3)
Value applied:	
Justification of the choice of data or description of measurement methods and procedures actually applied :	<table><tr><td>Waster type j</td><td>Boreal and temperate(MAT≤20℃), Dry (MAP/PET<1)</td></tr><tr><td>Pulp, paper, cardboard (other than sludge), textiles</td><td>0.04</td></tr><tr><td>Wood, wood products and straw</td><td>0.02</td></tr><tr><td>Other (non-food) organic putrescible garden and park</td><td>0.05</td></tr></table>

	<table><tr><td>waste</td><td></td></tr><tr><td>Food, food waste, sewage sludge, beverages and tobacco</td><td>0.06</td></tr></table>
Justification of the choice of data or description of measurement methods and procedures actually applied :	The mean annual temperature of Liaoning province is 6℃～10℃ and the mean annual precipitation is lower than the potential evapotranspiration except for the east areas.See Annex 3 for detailed information.
Any comment:	Document in the CDM-PDD the climatic conditions at the SWDS site (temperature, precipitation and, where applicable, evapotranspiration). Use long-term averages based on statistical data, where available. Provide references.

B.6.3 Ex-ante calculation of emission reductions:

Annex 3 presents the details of emission reduction calculation.

Following the formula (1) ~ (18), the results of baseline emissions and the emission reductions from the project are summarised below.

Baseline emissions (BL_y **)**

The estimated LFG generation and utilization, as well as the baseline emissions in Zhaojiagou, Gaoguanling and Langshan landfill sites for the crediting period of 10 years are shown in the following table:

Table 10: Estimated LFG Collection and Utilization in Zhaojiagou

Crediting period (Year)	$BE_{CH4,SWDS,y}/GWP_{CH4}$ (tCH4)	Collection Efficiency (%)	$MD_{captured,y}$ (tCH4)	$LFG_{captured,y}$ (Nm^3)	$LFG_{thermal,y}$ (Nm^3)	$LFG_{flare,y}$ (Nm^3)	$MD_{project,y}$ (tCH4)
	A	B	C=A*B	D	E	F=D-E	G
2009	1,937	60	1,162	3,241,175	2,342,082	899,093	1,130
2010	1,838	60	1,103	3,075,323	2,991,067	84,255	1,099
2011	1,744	60	1,046	2,918,341	2,838,386	79,955	1,043
2012	1,655	60	993	2,769,743	2,693,860	75,883	990
2013	1,571	60	943	2,629,069	2,557,040	72,029	940
2014	1,491	60	895	2,495,884	2,427,504	68,380	892
2015	1,416	60	850	2,369,779	2,304,854	64,925	847
2016	1,345	60	807	2,250,366	2,188,712	61,654	805
2017	1,277	60	766	2,137,280	2,078,725	58,556	764
2018	1,213	60	728	2,030,176	1,974,554	55,621	726

Table 11: Estimated baseline emission of Zhaojiagou Project

Crediting period (Year)	$MD_{project,y}$ (tCH4)	GWPCH4 (tCO2e/tCH4)	$BL_{CH4,y}$ (tCO2e)	$M_{hotwater}$ (tone)	$BL_{thermal,y}$ (tCO2e)	BL_y (tCO2e)
	G	H	I=G*H	J	K	L=I+K
2009	1,130	21	23,724	95,546	2,681	26,405
2010	1,099	21	23,089	122,022	3,424	26,513
2011	1,043	21	21,911	115,793	3,249	25,159
2012	990	21	20,795	109,897	3,084	23,878
2013	940	21	19,739	104,316	2,927	22,666
2014	892	21	18,739	99,031	2,779	21,517
2015	847	21	17,792	94,028	2,638	20,430
2016	805	21	16,895	89,290	2,505	19,401
2017	764	21	16,046	84,803	2,379	18,426
2018	726	21	15,242	80,553	2,260	17,502

Table 12: Estimated LFG Collection and Utilization in Gaoguanling

Crediting period (Year)	$BE_{CH4,SWDS,y}/GWP_{CH4}$ (tCH4)	Collection Efficiency (%)	$MD_{captured,y}$ (tCH4)	$LFG_{captured,y}$ (Nm^3)	$LFG_{thermal,y}$ (Nm^3)	$LFG_{flare,y}$ (Nm^3)	$MD_{project,y}$ (tCH4)
	A	B	C=A*B	D	E	F=D-E	G
2009	1,576	60	946	2,638,047	1,906,260	731,787	920
2010	1,497	60	898	2,505,559	2,436,914	68,645	896
2011	1,422	60	853	2,380,077	2,314,869	65,208	851
2012	1,351	60	811	2,261,218	2,199,266	61,951	808
2013	1,284	60	770	2,148,621	2,089,755	58,866	768
2014	1,220	60	732	2,041,948	1,986,004	55,944	730
2015	1,160	60	696	1,940,875	1,887,700	53,175	694
2016	1,102	60	661	1,845,098	1,794,548	50,551	660
2017	1,048	60	629	1,754,332	1,706,268	48,064	627
2018	997	60	598	1,668,304	1,622,597	45,707	596

Table 13: Estimated baseline emission of Gaoguanling Project

Crediting period (Year)	$MD_{project,y}$ (tCH4)	GWPCH4 (tCO2e/tCH4)	$BL_{CH4,y}$ (tCO2e)	$M_{hotwater}$ (tone)	$BL_{thermal,y}$ (tCO2e)	BL_y (tCO2e)
	G	H	I=G*H	J	K	L=I+K
2009	920	21	19,310	77,767	2,182	21,492
2010	896	21	18,811	99,415	2,789	21,601
2011	851	21	17,869	94,436	2,650	20,519
2012	808	21	16,977	89,720	2,517	19,494
2013	768	21	16,132	85,253	2,392	18,524
2014	730	21	15,331	81,020	2,273	17,604
2015	694	21	14,572	77,010	2,161	16,733
2016	660	21	13,853	73,209	2,054	15,907
2017	627	21	13,171	69,608	1,953	15,124
2018	596	21	12,525	66,195	1,857	14,383

Table 14: Estimated LFG Collection and Utilization in Langshan

Crediting period (Year)	$BE_{CH4,SWDS,y} / GWP_{CH4}$ (tCH4)	Collection Efficiency (%)	$MD_{captured,y}$ (tCH4)	$LFG_{captured,y}$ (Nm^3)	$LFG_{thermal,y}$ (Nm^3)	$LFG_{flare,y}$ (Nm^3)	$MD_{project,y}$ (tCH4)
	A	B	C=A*B	D	E	F=D-E	G
2009	2,470	50%	1,235	3,445,482	2,380,882	1,064,600	1,197
2010	2,556	50%	1,278	3,564,344	3,204,600	359,744	1,265
2011	2,422	50%	1,211	3,378,564	3,204,600	173,964	1,205
2012	2,296	50%	1,148	3,202,855	3,115,106	87,749	1,145
2013	2,177	50%	1,089	3,036,658	2,953,462	83,196	1,086
2014	2,065	50%	1,032	2,879,446	2,800,557	78,889	1,029
2015	1,958	50%	979	2,730,721	2,655,907	74,814	976
2016	1,857	50%	929	2,590,015	2,519,055	70,959	926
2017	1,762	50%	881	2,456,883	2,389,572	67,312	878
2018	1,671	50%	836	2,330,909	2,267,048	63,861	833

Table 15: Estimated baseline emission of Langshan Project

Crediting period (Year)	$MD_{project,y}$ (tCH4)	GWPCH4 (tCO2e/tCH4)	$BL_{CH4,y}$ (tCO2e)	$M_{hotwater}$ (tone)	$BL_{thermal,y}$ (tCO2e)	BL_y (tCO2e)
	G	H	I=G*H	J	K	L=I+K
2009	1,197	21	25,138	97,129	2,725	27,863
2010	1,265	21	26,563	130,733	3,668	30,231
2011	1,205	21	25,305	130,733	3,668	28,973
2012	1,145	21	24,047	127,082	3,566	27,612
2013	1,086	21	22,799	120,488	3,381	26,180
2014	1,029	21	21,619	114,250	3,206	24,824
2015	976	21	20,502	108,349	3,040	23,542
2016	926	21	19,446	102,766	2,883	22,329
2017	878	21	18,446	97,484	2,735	21,181
2018	833	21	17,500	92,485	2,595	20,095

Project Emissions

The project emissions, consisting of emissions from consumption of electricity in project case ($PE_{EC,y}$) and emissions from consumption of heat in the project case ($PE_{FC,y}$), are listed in the following table.

Table 16 Ex-ante estimation of project emissions of Zhaojiagou Project

Crediting period (Year)	$PE_{FC,y}$	$PE_{EC,y}$	PE_y
	M	N	O=M+N
2009	144	584	728
2010	184	584	768
2011	174	584	758
2012	166	584	749

2013	157	584	741
2014	149	584	733
2015	142	584	725
2016	135	584	718
2017	128	584	712
2018	121	584	705

Table 17 Ex-ante estimation of project emissions of Gaoguanling Project

Crediting period (Year)	$PE_{FC,y}$	$PE_{EC,y}$	PE_y
	M	N	O=M+N
2009	98	584	681
2010	125	584	709
2011	119	584	702
2012	113	584	696
2013	107	584	691
2014	102	584	685
2015	97	584	680
2016	92	584	676
2017	87	584	671
2018	83	584	667

Table 18 Ex-ante estimation of project emissions of Langshan Project

Crediting period (Year)	$PE_{FC,y}$	$PE_{EC,y}$	PE_y
	M	N	O=M+N
2009	122	584	706
2010	164	584	748
2011	164	584	748
2012	160	584	743
2013	151	584	735
2014	143	584	727
2015	136	584	720
2016	129	584	713
2017	122	584	706
2018	116	584	700

Leakage
There is no leakage, so for all these three projects,
L_y=0

Emission Reductions

As described in section B6.1, the emission reductions ER_y of the project activity during a given year y is the difference between baseline emission (BE_y), project emissions (PE_y) and emission due to leakage (L_y), as follows:

$$ER_y = BE_y - PE_y - L_y$$

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

According to the tables presented in B.6.3, the proposed project will generate a total amount of emission reductions during 10-year crediting period of 634,667 tCO2e, as shown in the following table.

Table 19: Summary of the estimated emission reductions for Zhaojiagou Project

Crediting period (Year)	Estimation of Baseline Emissions (tCO2e)	Estimation of project activity emission (tCO2e)	Estimation of Leakage (tCO2e)	Estimation of Emission Reduction (tCO2e)
	L	O	P	Q=L-O-P
2009	26,405	728	0	25,677
2010	26,513	768	0	25,745
2011	25,159	758	0	24,401
2012	23,878	749	0	23,129
2013	22,666	741	0	21,925
2014	21,517	733	0	20,784
2015	20,430	725	0	19,705
2016	19,401	718	0	18,682
2017	18,426	712	0	17,714
2018	17,502	705	0	16,797
Total	**221,898**	**7,337**	**0**	**214,561**

Table 20: Summary of the estimated emission reductions for Gaoguanling Project

Crediting period (Year)	Estimation of Baseline Emissions (tCO2e)	Estimation of project activity emission (tCO2e)	Estimation of Leakage (tCO2e)	Estimation of Emission Reduction (tCO2e)
	L	O	P	Q=L-O-P
2009	21,492	681	0	20,810
2010	21,601	709	0	20,892
2011	20,519	702	0	19,817
2012	19,494	696	0	18,798
2013	18,524	691	0	17,833
2014	17,604	685	0	16,918
2015	16,733	680	0	16,052
2016	15,907	676	0	15,231
2017	15,124	671	0	14,453
2018	14,383	667	0	13,716
Total	**181,380**	**6,859**	**0**	**174,521**

Table 21: Summary of the estimated emission reductions for Langshan Project

Crediting period (Year)	Estimation of Baseline Emissions (tCO2e)	Estimation of project activity emission (tCO2e)	Estimation of Leakage (tCO2e)	Estimation of Emission Reduction (tCO2e)
	L	O	P	Q=L-O-P
2009	27,863	706	0	27,157
2010	30,231	748	0	29,484
2011	28,973	748	0	28,225
2012	27,612	743	0	26,869
2013	26,180	735	0	25,444
2014	24,824	727	0	24,097
2015	23,542	720	0	22,822
2016	22,329	713	0	21,616
2017	21,181	706	0	20,475
2018	20,095	700	0	19,395
Total	**252,831**	**7,246**	**0**	**245,585**

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

B.7.1 Data and parameters monitored:

Data / Parameter:	**$LFG_{total,y}$**
Data unit:	m^3
Description:	Total amount of landfill gas captured at Normal Temperature and Pressure in year y
Source of data to be used:	Project participants
Value of data applied for the purpose of calculating expected emission reductions in section B.5	See Annex 3
Description of measurement methods and procedures to be applied:	Measured by a continuous flow meter. Data to be aggregated monthly and yearly. Archived data will be kept during the crediting period and two years after.
QA/QC procedures to be applied:	Flow meters will be subject to a regular maintenance and testing regime, in accordance with the manufacturer's specifications, to ensure measurement accuracy.
Any comment:	

Data / Parameter:	**$LFG_{thermal,y}$**
Data unit:	m^3
Description:	Amount of landfill gas at Normal Temperature and Pressure in year y which is

	destructed in boiler to produce hot water
Source of data to be used:	Project participants
Value of data applied for the purpose of calculating expected emission reductions in section B.5	See Annex 3
Description of measurement methods and procedures to be applied:	Measured by a continuous flow meter. Data to be aggregated monthly and yearly. Archived data will be kept during the crediting period and two years after.
QA/QC procedures to be applied:	Flow meters will be subject to a regular maintenance and testing regime, in accordance with the manufacturer's specifications, to ensure measurement accuracy.
Any comment:	

Data / Parameter:	$\mathbf{LFG_{flared,y}}$
Data unit:	m^3
Description:	Amount of landfill gas flared at Normal Temperature and Pressure in year y
Source of data to be used:	Project participants
Value of data applied for the purpose of calculating expected emission reductions in section B.5	See Annex 3
Description of measurement methods and procedures to be applied:	Measured by a continuous flow meter. Data to be aggregated monthly and yearly. Archived data will be kept during the crediting period and two years after.
QA/QC procedures to be applied:	Flow meters will be subject to a regular maintenance and testing regime, in accordance with the manufacturer's specifications, to ensure measurement accuracy.
Any comment:	

Data / Parameter:	$\mathbf{T_{flare}}$
Data unit:	℃
Description:	Temperature in the exhaust gas of the flare
Source of data to be used:	Project participants
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Above 500℃

Description of measurement methods and procedures to be applied:	Continuously measurement of the temperature of the exhaust gas stream in the flare by a thermocouple. A temperature above 500℃ indicates that a significant amount of gases are still being burnt and that the flare is operating. Measured data will be aggregated yearly and archived. Archived data will be kept during the crediting period and two years after
QA/QC procedures to be applied:	Thermocouples should be calibrated every year.
Any comment:	An excessively high temperature at the sampling point (above 700℃) may be an indication that the flare is not being adequately operated or that its capacity is not adequate to the actual flow.

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:	To be measured continuously by project participants using certified equipment
Value of data applied for the purpose of calculating expected emission reductions in section B.5	See Annex 3
Description of measurement methods and procedures to be applied:	Shall be measured using equipment that can directly measure methane content in the landfill gas, estimation of methane content of landfill gas based on measurement of other constituents of the landfill gas such as CO2 is not permitted. Preferably measured by continuous gas quality analyser. Data to be aggregated monthly and yearly. Archived data will be kept during the crediting period and two years after.
QA/QC procedures to be applied:	The gas analyser will be subject to a regular maintenance and testing regime, in accordance with the manufacturer's specifications, to ensure accuracy.
Any comment:	

Data / Parameter:	**T**
Data unit:	℃
Description:	Temperature of the landfill gas
Source of data to be used:	Project participants
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0
Description of measurement methods and procedures to be applied:	Measured continuously to determine the density of methane Density. No separate monitoring of temperature is necessary when using flow meters that automatically measure temperature and pressure, expressing LFG volumes in normalized cubic meters.

	Data to be aggregated monthly and yearly. Archived data will be kept during the crediting period and two years after.
QA/QC procedures to be applied:	Measuring instruments will be subjected to a regular maintenance and testing regime in accordance to appropriate national/international standards.
Any comment:	

Data / Parameter:	**P**
Data unit:	Pa
Description:	Pressure of the landfill gas
Source of data to be used:	Project participants
Value of data applied for the purpose of calculating expected emission reductions in section B.5	101,325
Description of measurement methods and procedures to be applied:	Measured continuously to determine the density of methane Density. No separate monitoring of pressure is necessary when using flow meters that automatically measure temperature and pressure, expressing LFG volumes in normalized cubic meters. Data to be aggregated monthly and yearly. Archived data will be kept during the crediting period and two years after.
QA/QC procedures to be applied:	Measuring instruments will be subject to a regular maintenance and testing regime in accordance to appropriate national/international standards.
Any comment:	

Data / Parameter:	$\mathbf{M_{hotwater}}$
Data unit:	tone
Description:	Mass of the outputted hot water
Source of data to be used:	Project participants
Value of data applied for the purpose of calculating expected emission reductions in section B.5	See Annex 3.
Description of measurement methods and procedures to be applied:	Measure discontinuously by a weight meter which measures the total weight of the truck and the loaded water Data will be aggregated monthly and yearly. Archived data will be kept during the crediting period and two years after.
QA/QC procedures to be applied:	Measuring instruments will be subject to a regular maintenance and testing regime in accordance to appropriate national/international standards.
Any comment:	

Data / Parameter:	$\mathbf{T_{avg,hotwater}}$
Data unit:	℃

Description:	Temperature of the output hot water
Source of data to be used:	Project participants
Value of data applied for the purpose of calculating expected emission reductions in section B.5	See Annex 3.
Description of measurement methods and procedures to be applied:	Measure discontinuously by a thermometer which measures the average temperature of hot water at customer side Data will be aggregated monthly and yearly. Archived data will be kept during the crediting period and two years after.
QA/QC procedures to be applied:	Measuring instruments will be subject to a regular maintenance and testing regime in accordance to appropriate national/international standards.
Any comment:	

Data / Parameter:	$\mathbf{T_{avg,feedwater}}$
Data unit:	℃
Description:	Temperature of the water fed into the boiler
Source of data to be used:	Project participants
Value of data applied for the purpose of calculating expected emission reductions in section B.5	See Annex 3.
Description of measurement methods and procedures to be applied:	Measure continuously by a flow meter which measures the temperature, pressure and flow rate. Data will be aggregated monthly and yearly. Archived data will be kept during the crediting period and two years after.
QA/QC procedures to be applied:	Measuring instruments will be subject to a regular maintenance and testing regime in accordance to appropriate national/international standards.
Any comment:	

Data / Parameter:	$\mathbf{EC_{pj,y}}$
Data unit:	MWh
Description:	Onsite consumption of electricity provided by the grid (NCPG) and attributable to the project activity during the year y
Source of data to be used:	Project participants
Value of data applied for the purpose of calculating expected emission reductions in section B.5	See Annex 3

Description of measurement methods and procedures to be applied:	Measured continuously by electricity meter. The data is aggregated at least annually and archived. Archived data will be kept during the crediting period and two years after.
QA/QC procedures to be applied:	Cross check measurement results with invoices for purchase electricity if relevant.
Any comment:	

Data / Parameter:	$FC_{diesel,y}$
Data unit:	tonne
Description:	the quantity of diesel combusted by the trucks transporting hot water during the year y
Source of data to be used:	Project participants
Value of data applied for the purpose of calculating expected emission reductions in section B.5	See Annex 3
Description of measurement methods and procedures to be applied:	The hot water will be transported to local heat customers by trucks. The project will be equipped with heavy duty trucks, but in the peak season part of the transportation may be carried out by outsourced trucks. The diesel consumption of project owned trucks will be monitored based on the diesel purchase record and be cross checked with the receipt. For outsourced trucks, the diesel consumption will be estimated based on the transportation records and the diesel consumption rate of the project owned trucks.
QA/QC procedures to be applied:	
Any comment:	

Data / Parameter:	**Operating hours**
Data unit:	hours
Description:	Operating hours of the boilers
Source of data to be used:	Project participants
Value of data applied for the purpose of calculating expected emission reductions in section B.5	8,520
Description of measurement methods and procedures to be applied:	On site measurement of the operating hours of the boilers, 100% of all data are measured and archived electronically, recording frequency will be annually
QA/QC procedures to	The meter will be calibrated regularly according to manufacturer's regulations

be applied:	
Any comment:	

Data / Parameter:	**Flare operation parameters**
Data unit:	
Description:	Manufacturer's specification of flare, such as temperature, flow rate of residual gas at the inlet of the flare
Source of data to be used:	On site measurements
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Assumed that all flare operation parameters meet the manufacturer's specifications, hence, the flare efficiency of the enclosed flared to be applied by the project is 90% for calculating the emission reductions.
Description of measurement methods and procedures to be applied:	Continuously
QA/QC procedures to be applied:	The operating conditions will be measured according to the manufacturer's specification.
Any comment:	

B.7.2 Description of the monitoring plan:

The monitoring plan specifies the necessary action to measure and record all the variables and factors required by the applicable monitoring methodology, version 08 of ACM0001, as described in detail in above section B.7.1.

The monitoring plan provides for continuous measurement of following:

Quantity of methane actually captured ($MD_{project,y}$);

Quantity of methane flared ($MD_{flared,y}$);

Quantity of methane used to generate thermal energy ($MD_{thermal,y}$);

Quantity of electricity consumed by the project activity ($EC_{pj,y}$)

Quantity of diesel combusted by the trucks transporting hot water ($FC_{diesel,y}$)

Quantity of thermal energy produced by the project activity ($ET_{LFG,y}$)

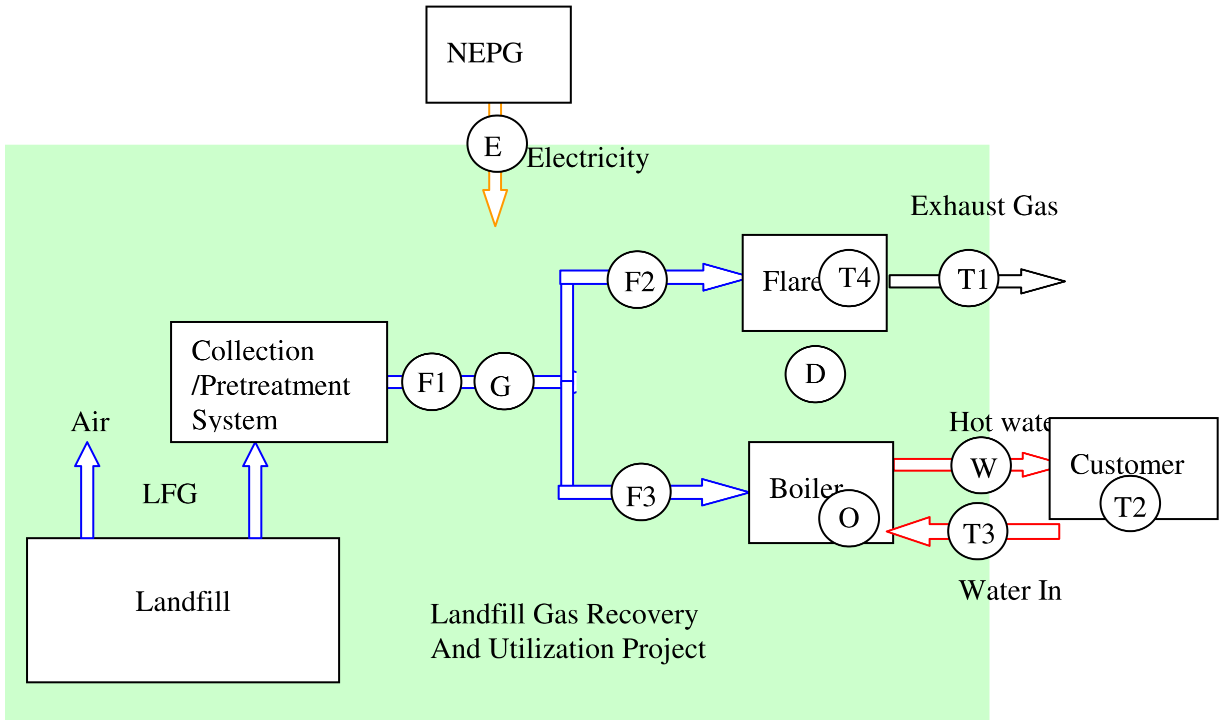
The monitoring plan also monitors the operation hours of the boiler and the operation parameters of the flare to evaluate the methane destruction efficiency.

Besides, the clarification of every hot water user regarding the historical hot water production, which indicates the coal and other fuel (if any) consumption as well as hot water production in recent years, will be collected to justify that coal-fired boilers has been replaced with the proposed project activity.

Liaoning Kaitian Renewable&Environment Co., Ltd, as the project developer, will invest, construct, operate and manage the proposed project and will be responsible for all monitoring activities, assuring that all activities are consistent with the monitoring plan.

Data Monitoring

The project participants will monitor the emission reductions by using the methods, indicators, and frequency required by Monitoring Methodology ACM0001 to ensure project emission reductions are measurable and real. The monitoring methodology is based on direct measurement and the monitoring data will be collected and documented.

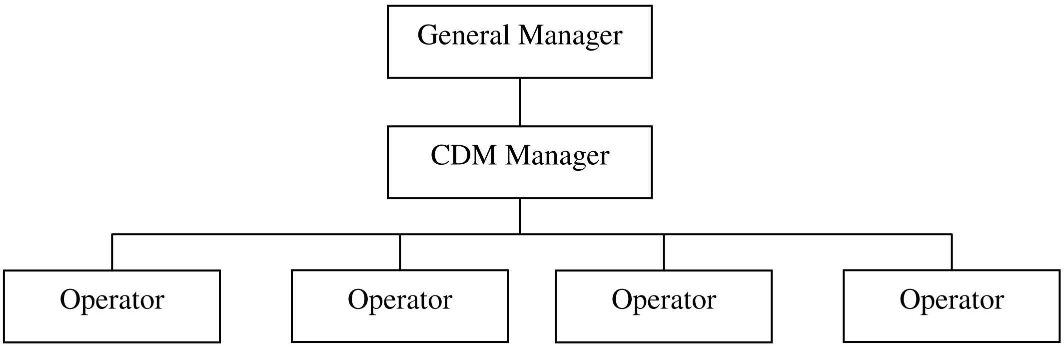


Legend:

F1	Flow meter to continuously measure the flow of total collected LFG and give the flow at normal conditions
G	Gas analyzer to measure methane fraction in LFG
F2	Flow meter to continuously measure the flow of LFG fed to the flare and give the flow at normal conditions
T1	Thermal couple to measure the temperature of the Exhaust Gas of the flare
F3	Flow meter to continuously measure the flow of LFG fed to the boiler and give the flow at normal conditions
T2	Thermometer to measure the average temperature of hot water at customer side
T3	Thermometer to measure the average temperature of the feed water to the boiler
E	Electricity meter to measure the electricity imported from NEPG

W	Wight of hot water, and times of round trips made by hot water transportation trucks
T4	Combustion temperature of the flare
O	Operation hours of boiler
D	Diesel consumption measured by the purchase record

Monitoring Management



General Manager: All issues related to CDM project monitoring are managed by general manager.

CDM Manager: He/She will be responsible for meters calibration, training, checking the daily operation report forms and archiving emergency situation reports. He/She will report monthly to the General Manager (GM) of the project developer about the project performance and monitored data. When a non-conformance in the performance to the mentioned regulations and/or problems in the performance of the monitoring equipment (e.g. flow meters not working, data not correct) are identified the CDM manager will inform the GM immediately of the situation and the measures that are/will be taken. Also the CDM manager will be responsible for aggregating the monitoring data monthly and yearly, and for archiving it and keeping it during the crediting period and two years after

Operators: Operators will take turns to work in the Control Center 24 hours and take charge of data supervision, check and inspection. They are responsible for executing the emergency plan (if necessary) and drafting operation report forms and emergency situation reports.

Training

For all employees involved in the CDM project, a Training Plan will be created to provide them the skills necessary to conduct their work in a safe manner and, ensuring the success of the project activity.

The CDM manager should ensure that only trained and skilled people work in the CDM project. Depending on their task, they should get a comprehensive knowledge with regard to the general and technical aspects of the project, as well as the basic understanding of CDM.

Quality control and quality assurance procedures

The whole CDM team will establish a quality management system, which ensures the quality and accuracy of the measured data, including corrective measures in case of non-conformity. The quality management system will include:

Data records

Daily readings of all field meters will be filled out in paper worksheets. All data collected will also be entered in electronic worksheets and stored in computer immediately and in discs periodically.
Periodic controls of the LFG field monitoring records will be carried out to check any deviations from the estimated ERs following the guidelines for LFG plant operation and monitoring for correction or future references.
Periodic reports to evaluate performance and assist with performance management will be documented.

Data evaluation

The whole CDM team will follow the main criteria, such as use and strict adherence to recognised standard methods, use of non-standard methods only after approved validation, use of standard reporting forms including process measures as well as emission data, etc. to guarantee that the data is reliable and accurate.

Equipment calibration and maintenance

Flow meters, gas analyzers, other critical CDM project equipment will be subject to regular maintenance and testing according to technical specifications from the manufactures to ensure accuracy and good performance.
Calibration of equipment will be conducted periodically according to their technical specifications.

Corrective actions

The quality control and quality assurance procedures include the handling and correction of nonconformities in the implementation of the project or the monitoring plan. In case such non-conformities are observed:

An analysis of the nonconformity and its causes will be carried out immediately by the CDM manager, with the help of other colleagues or external experts if necessary

A corrective action plan should then be developed to eliminate the non-conformity and its causes

Corrective actions are implemented and reported back to the CDM Manager and the GM

Relative information will be included in the monitoring report and reported to DOE during the verification.

Emergency procedures for unintended emissions

In case of equipment malfunction or breakdown, corrective actions will be carried out to minimize the unintended emissions.

Verification

It is expected that the verification of emission reductions generated from the proposed project activity will be performed annually. The following table outlines the key documents relevant to monitoring and verification of the emission reductions from the proposed project activity.

Table 22: Key documents relevant to monitoring and verification

Document Title	**Main Content**	**Source**
PDD, including the electronic spreadsheets and supporting documentation	Calculation procedure of emission reduction and monitoring items	Project owner, or CDM consultant, or directly download from UNFCCC website
Meter calibration report	Equipment and national and	Qualified institution or entity

Document Title	Main Content	Source
	industry standards	
Process Report for Calibration	Starting time and ending time of calibration; reasons for maintenance and calibration and precision after maintenance and calibration.	Project owner
Operation Report Forms	The data of metering equipments, abnormal situations	Project owner
Emergency Situation Report	The process of the event and the countermeasures	Project owner
Relative materials about training	Training plan; training material, training reports	Project owner
Monitoring Report	CO2 emission reductions calculation	Project owner or CDM consultant

B.8 Date of completion of the application of the baseline study and monitoring methodology and the name of the responsible person(s)/entity(ies)

Date of completion of current version of baseline study and monitoring methodology: 11 November 2008

The names of the responsible persons are:

Mr. Clive Huang, Mr. Wayne Zhou, Ms. Chen Boping
IT Power Beijing Representative Office
Address: Room 601, Air China Plaza, No. 36 Xiaoyun Road, Chaoyang District, Beijing 100027, P.R.China
Tel: 86-10-84475848
Fax: 86-10-84475940
Email ; clive.huang@itpowergroup.com; zhou.wei@itpowergroup.com; chen.boping@itpowergroup.com

IT Power Beijing Representative Office is not 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:

The starting date of Gaoguanling project is 20th Feb 2008 when the purchase contract for the flare was signed while the equipment purchase and construction of Zhaojiagou and Langshan project started in October, 2008.
So for the proposed project activity, the starting date should be adopted as the earliest date of these three projects, i.e. 20th Feb 2008.

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

All of the three projects have an expected lifetime of 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:

15/04/2009, or the registration date, whichever is later

C.2.2.2. Length:

10 years and 0 month.

SECTION D. Environmental impacts

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

The Environmental Impact Assessment (EIA) for the proposed project was carried out by ACRE Coking & Refractory Engineering Consulting Corporation (for Gaoguanling project), Shenyang Environment Protection Research Institute (for Zhaojiagou project) and Chaoyang Environment Protection Research Institute (for Langshan project). Both referred organisations are eligible for undertaking EIAs. All three EIA reports have already been approved by the competent authority. Summarised below are the environmental impacts possibly caused by the proposed project and relevant countermeasures to be adopted by the project owner outlined by the EIAs and Feasibility Study Reports.

Expected Environmental impacts during construction:
Atmosphere
Construction machineries and vehicles exhaust gases release. And, increase in air suspended particles in result from on site civil works, loading/unloading building materials and cleaning solid wastes. These impacts can be minimised by frequent on site water spraying.

Noise
Noise sources mainly include construction machineries and vehicles during civil works and electric saws and cranes during fit-out and installation of electrical and mechanical equipments. Noise requirements will follow the national standard GB12523-90, “Noise Limits at Construction Site Boundary”, and construction hours will be appropriately scheduled.

Wastewater
Wastewater during the construction period will mainly comprise production sewage and sanitary sewage. Production sewage results from excavated slurry, cooling and washing of the construction machineries. Wastewater will be collected and be treated at other local treatment facilities.

Solid waste
Construction debris includes waste building materials, sand and gravel material, construction soil, broken bricks, concrete and discarded equipment parts, etc. Construction solid waste and domestic solid waste on site will be collected and disposed regularly.

Expected Environmental impacts during operation:
Atmosphere
Positive environmental impact resulting from the main purpose of the proposed project: reduction of greenhouse gas methane in the LFG, as H_2S and NH_3.

Wastewater
Water resulting from the condensation from the gas collection system will be used for the irrigation of nearby plants.

Noise
Machine operation will produce noise. Noise mainly comes from blower. The noise generated by the project will have a minimum impact on the environment and surrounding populations due to the separation of the equipments from the environment through walls and due to the distance of those from the closed populations

Solid waste
The operation of the power plant creates no extra solid waste. No additional fossil fuel based system is used and no ash and slag is produced. Thus the project imposes no impact on the environment in terms of solid waste.

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:

As discussed in above section, the environmental impacts of the propose project activity are not considered significant by the competent authorities of the host Party. Recovery and utilization of the landfill gas for thermal energy generation is an effective approach to reduce local environmental pollution as well as to provide clean energy for residue use.

SECTION E. Stakeholders’ comments

>>

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

All CDM projects must carry out a public stakeholder's consultation on the project. In order to gather public attitude towards the proposed project, the project owner has distributed questionnaires soliciting public input in March/June 2008. The questionnaire used consisted of a brief introduction of the proposed project, its contribution to reducing CO2 reductions and a series of questions. The questions included in the questionnaires are listed in the table in section E.2.

A total of 240 (80 for each of the three landfill sites) copies of the questionnaire were distributed randomly to respondents from local residential areas, workers, local officials and so on. The survey was carried out as an on-site paper interview. At the same time, respondent's comments that were beyond the coverage of the questions in the questionnaire were carefully recorded.

E.2. Summary of the comments received:

The feedback from the questionnaire survey is as follows:

Table 23: Summary of questionnaire results

		Gaoguanling	Zhaojiagou	Langshan
Gender	Male	56.3%	52.5%	42.5%
	Female	43.8%	47.5%	57.5%
Age	18-30 years old	43.8%	51.3%	37.5%
	31-50 years old	46.3%	40.0%	51.3%
	51-65 years old	10.0%	8.8%	11.3%
	above 66 years old	0.0%	0.0%	0.0%
Occupation	Farmer	7.5%	2.5%	13.8%
	Worker	32.5%	35.0%	40.0%
	Official	20.0%	16.3%	10.0%
	Others	40.0%	46.3%	36.3%
Educational Level	Primary school	0.0%	0.0%	8.8%
	Junior school	11.3%	10.0%	17.5%
	Senior high school	40.0%	35.0%	31.3%
	Bachelor degree or above	48.8%	55.0%	42.5%
What do you think of the current environmental status in local areas?	Very satisfying	1.3%	1.3%	0.0%
	Comparatively Satisfying	15.0%	18.8%	1.3%
	Dissatisfying	66.3%	57.5%	66.3%
	Very dissatisfying	17.5%	22.5%	32.5%
What is the major environmental problem in local areas?	Air pollution	80.0%	52.5%	30.0%
	Water pollution	6.3%	7.5%	11.3%
	Solid waste	10.0%	37.5%	52.5%
	Noise pollution	3.8%	2.5%	6.3%
From which source did you hear about the proposed project?	Newspaper	0.0%	0.0%	0.0%
	TV/Broadcast	0.0%	0.0%	0.0%

		Gaoguanling	Zhaojiagou	Langshan
	Internet	50.0%	32.5%	20.0%
	Project Dissemination	50.0%	67.5%	80.0%
Do you know the landfill gas recovery and utilization technology?	Yes	37.5%	20.0%	8.8%
	No	62.5%	80.0%	91.3%
What do you think of the main pollutions of the waste landfill site?	Air pollution	77.5%	66.3%	51.3%
	Water pollution	18.8%	28.8%	23.8%
	Solid waste	23.8%	45.0%	61.3%
	Noise pollution	2.5%	3.8%	3.8%
What do you think of the intensity of the pollutions of the waste landfill site?	Heavy	30.0%	31.3%	36.3%
	Average	68.8%	68.8%	63.8%
	Light	1.3%	0.0%	0.0%
In what aspects do you think the proposed project activity will affect the environment?	Air	71.3%	57.5%	36.3%
	Water	5.0%	5.0%	3.8%
	Solid	18.8%	33.8%	58.8%
	Noise	5.0%	3.8%	1.3%
What kind of overall impact do you think will the proposed project impose on the local environment?	Positive impact	92.5%	98.8%	100.0%
	Negative impact	0.0%	1.3%	0.0%
	Little impact	7.5%	0.0%	0.0%
What measures should be taken for environmental protection during construction/operation period?	Solid waste disposal	11.3%	30.0%	76.3%
	Water waste disposal	2.5%	1.3%	5.0%
	Gas waste disposal	86.3%	63.8%	16.3%
	Noise control	0.0%	5.0%	2.5%
To whom will you report when encountering environmental problem?	Environmental Protection Agency	63.8%	62.5%	21.3%
	Environmental Sanitation Management Office	25.0%	17.5%	45.0%
	Government	8.8%	15.0%	27.5%
	Waste landfill site	2.5%	5.0%	6.3%
In what degree will you participate in the supervision of environment during and after the proposed project construction?	Very strong	25.0%	32.5%	6.3%
	Strong	51.3%	52.5%	30.0%
	Common	22.5%	13.8%	63.8%
	Little	1.3%	1.3%	0.0%
Do you support the proposed project?	Yes	100.0%	100.0%	100.0%
	No	0.0%	0.0%	0.0%

The above table clearly shows that more than half of the respondents are not satisfied with the current local environment near the landfill sites, and they have highlighted air pollution as one of the main environment problem. Most of them believe that the proposed project will have a positive impact on the local environment, and all of them support the proposed project.

Other comments and recommendations included in the questionnaires were:

- need to do more plantation in the landfill site;
- reduce noise pollution as much as possible;
- try to use the energy from LFG in a most efficient way;
- expand the technology into more other landfill sites.

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

Air has been identified by most respondents to be the key issue of the proposed project. The proposed project activity per se will significantly contribute to the reduction of air pollution due to the CH_4 that would be emitted to the atmosphere in business-as-usual scenario. In addition, certain countermeasures will be taken to alleviate the air pollution by dust during construction period.

In general, the local community gives strong positive comments on the effects that the project activity will make on the local economy and infrastructure. There consequently has no reason to modify the plans due to comments received.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

Organization:	Liaoning Kaitian Renewable&Environment Co., Ltd (辽宁凯田再生能源环保有限公司)
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Represented by:	Mr. Liu Shijun
Title:	Managing Director
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Annex 2

INFORMATION REGARDING PUBLIC FUNDING

No public funds from Annex 1 country are involved in the proposed project.

Annex 3

BASELINE INFORMATION

1 Determination of landfill gas generation at the the proposed landfill sites

$$BE_{CH4,SWDS,y} = \varphi \cdot (1-f) \cdot GWP_{CH4} \cdot (1-OX) \cdot \frac{16}{12} \cdot F \cdot DOC_f \cdot MCF \cdot \sum_{x=1}^{y} \sum_{j} W_{j,x} \cdot DOC_j \cdot e^{-k_j \cdot (y-x)} \cdot (1-e^{-k_j})$$

The values of the above parameters are listed in the following tables:

Parameter	Unit	Value	Source
φ		0.9	Default value from Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site
f	%	0	Operation records from landfill operator
OX		0.1	2006 IPCC Guidelines for National Greenhouse Gas Inventories
F	%	50	2006 IPCC Guidelines for National Greenhouse Gas Inventories
DOC_f		0.5	2006 IPCC Guidelines for National Greenhouse Gas Inventories
MCF		1.0	2006 IPCC Guidelines for National Greenhouse Gas Inventories
GWP_{CH4}		21	2006 IPCC Guidelines for National Greenhouse Gas Inventories

Given that the mean annual temperature of Liaoning province is 6℃～10℃[11], and the mean annual precipitation is lower than the potential evapotranspiration except for the east areas[12].

Waste type	DOC_j (for wet waste)	k_j (MAT <=20 ℃, dry)	Waste composition (%)		
			Gaoguanling	Zhaojiagou	Langshan
Wood and wood products	0.43	0.02	2.6	3.71	3.43
Pulp, paper and cardboard (other than sludge)	0.40	0.04	5.47	7.79	6.83
Food, food waste, beverages and tobacco (other than sludge)	0.15	0.06	39.8	56.73	62.38
Textiles	0.24	0.04	1.13	1.60	1.58
Garden, yard and park waste	0.20	0.05	4.85	6.9	6.37
Glass, plastic, metal, other inert waste	0		46.15	23.27	19.41

Source: 2006 IPCC Guidelines for National Greenhouse Gas Inventories; Operation records from landfill operator

[11] http://www.lnmb.gov.cn/detail.asp?id=4398

[12] http://218.25.120.69/ArticleInfo.asp?ChannelID=0404&Articleid=200603100004

Wx: MSW dumped in the year x at the landfill sites

Year	Quantity (tones)		
	Gaoguanling	Zhaojiagou	Langshan
1985	164,250		
1986	164,250		
1987	164,250		
1988	164,250		
1989	164,250		
1990	164,250		
1991	164,250		
1992	164,250		97,601
1993	164,250		97,601
1994	164,250		97,601
1995	164,250		97,601
1996	164,250		97,601
1997	164,250		97,601
1998	164,250	255,500	97,601
1999	164,250	255,500	97,601
2000	164,250	255,500	97,601
2001		255,500	104,573
2002		255,500	104,573
2003		255,500	104,573
2004			104,573
2005			104,573
2006			104,573
2007			104,573
2008			104,573*
2009			104,573*
2010			104,573*

Source: Operation records from landfill operator
*: The data for 2008~2010 is by estimation.

And it should also be noticed that as a common practice, the generated LFG couldn't be fully captured by the proposed project activity. The first reason is the poor covering. For all these three landfills, Zhaojiagou and Gaoguanling landfills have been covered by soil and will be recovered by soil with the proposed project so the total depth of covering can reach about 1.5 meter. For Langshan landfill, it is still operational and not covered yet. Even with soil covering it is still far from enough and according to the previous practice of the project owner 30%~40% of the generated LFG will escape from the covering.

The second reason is that due to the local terrain and the un-strict management of the disposal of MSW, it is hard and unprofitable to cover all the disposal area by the LFG collection system. The percentage is estimated to fall in the range of 85%~90%.

There are also some other issues related to the LFG collection. The leak of the pipes is small but noticeable, maybe 2%~5%; and it's not possible for the pipe network and the pumps to work properly every second especially during the cold winter (mean monthly temperature of -10.7℃[11] in January).

Based on the above considerations, the FSR estimates an overall LFG collection efficiency of 50% for Langshan landfill which is still under operation and result in a lower coverage of the LFG collection system, and 60% for the other two landfills which has been closed. The only available reference project utilizing the same IPCC first decay model is *Tianjin Shuangkou Landfill Gas Recovery and Electricity Generation* project (Ref 1406) which has the similar situation and adopts an overall efficiency of 45~60%.

Here are the main parameters for the estimation of LFG generation, collection and utilization. Since all these three projects have the same boiler, it is applicable for all these three projects.

Table 24: Parameters for LFG utilization and hot water production

Parameters	**Value**	**Unit**	**Source**
capacity of boiler	2	t/h	
number of boilers	1		FSR
steam temperature	168	□	FSR
steam pressure	0.7	Mpa	FSR
enthalpy of saturated steam under above conditions	2763.29	kj/kg	
temperature fed water	15	□	FSR
enthalpy of fed water	62.7	kJ/kg	
temperature of produced hot water	95	℃	FSR
density of CH_4	0.717	kg/m^3	FSR
fraction of CH4 in LFG	50%	by volume	
NCV of LFG	17.95	MJ/m3	FSR
efficiency of bolier	80%		FSR
efficiency of steam/water heat changer	95%		FSR
overall efficiency of bolier system	76%		FSR
methane destruction efficiency of flare	90%		Assumed
daily LFG consumption of a boiler	9027		Calculated
Maintenance of boiler	10	days/a	FSR

The captured LFG will be mainly fed to the boiler ($LFG_{thermal,y}$) when the boiler is operating well, and all the LFG which is not utilized in the boiler will be fed to the flare. So the landfill gas generation and collection can be estimated as follows:

Table 25: Estimated LFG Generation and Collection in Zhaojiagou

Crediting period (Year)	$BE_{CH4,SWDS,y}/GWP_{CH4}$ (tCH4)	Collection Efficiency (%)	$MD_{captured,y}$ (tCH_4)	$LFG_{captured,y}$ (Nm^3)	$LFG_{thermal,y}$ (Nm^3)	$LFG_{flare,y}$ (Nm^3)	Hot Water Production (tone)	$BL_{CH4,y}$ (tCO2e)
	A	B	C=A*B	D	E	F	G	H
2009	1,937	60	1,162	3,241,175	2,342,082	899,093	95,546	23,724
2010	1,838	60	1,103	3,075,323	2,991,067	84,255	122,022	23,089
2011	1,744	60	1,046	2,918,341	2,838,386	79,955	115,793	21,911
2012	1,655	60	993	2,769,743	2,693,860	75,883	109,897	20,795
2013	1,571	60	943	2,629,069	2,557,040	72,029	104,316	19,739
2014	1,491	60	895	2,495,884	2,427,504	68,380	99,031	18,739
2015	1,416	60	850	2,369,779	2,304,854	64,925	94,028	17,792
2016	1,345	60	807	2,250,366	2,188,712	61,654	89,290	16,895
2017	1,277	60	766	2,137,280	2,078,725	58,556	84,803	16,046
2018	1,213	60	728	2,030,176	1,974,554	55,621	80,553	15,242

Table 26: Estimated LFG Generation and Collection in Gaoguanling

Crediting period (Year)	$BE_{CH4,SWDS,y}/GWP_{CH4}$ (tCH4)	Collection Efficiency (%)	$MD_{captured,y}$ (tCH_4)	$LFG_{captured,y}$ (Nm^3)	$LFG_{thermal,y}$ (Nm^3)	$LFG_{flare,y}$ (Nm^3)	Hot Water Production (tone)	$BL_{CH4,y}$ (tCO2e)
	A	B	C=A*B	D	E	F	G	H
2009	1,576	60	946	2,638,047	1,906,260	731,787	77,767	19,310
2010	1,497	60	898	2,505,559	2,436,914	68,645	99,415	18,811
2011	1,422	60	853	2,380,077	2,314,869	65,208	94,436	17,869
2012	1,351	60	811	2,261,218	2,199,266	61,951	89,720	16,977
2013	1,284	60	770	2,148,621	2,089,755	58,866	85,253	16,132
2014	1,220	60	732	2,041,948	1,986,004	55,944	81,020	15,331
2015	1,160	60	696	1,940,875	1,887,700	53,175	77,010	14,572
2016	1,102	60	661	1,845,098	1,794,548	50,551	73,209	13,853
2017	1,048	60	629	1,754,332	1,706,268	48,064	69,608	13,171
2018	997	60	598	1,668,304	1,622,597	45,707	66,195	12,525

Table 27: Estimated LFG Generation and Collection in Langshan

Crediting period (Year)	$BE_{CH4,SWDS,y}/GWP_{CH4}$ (tCH4)	Collection Efficiency (%)	$MD_{captured,y}$ (tCH_4)	$LFG_{captured,y}$ (Nm^3)	$LFG_{thermal,y}$ (Nm^3)	$LFG_{flare,y}$ (Nm^3)	Hot Water Production (tone)	$BL_{CH4,y}$ (tCO2e)
	A	B	C=A*B	D	E	F	G	H
2009	2,470	50	1,235	3,445,482	2,380,882	1,064,600	97,129	25,138
2010	2,556	50	1,278	3,564,344	3,204,600	359,744	130,733	26,563
2011	2,422	50	1,211	3,378,564	3,204,600	173,964	130,733	25,305
2012	2,296	50	1,148	3,202,855	3,115,106	87,749	127,082	24,047
2013	2,177	50	1,089	3,036,658	2,953,462	83,196	120,488	22,799
2014	2,065	50	1,032	2,879,446	2,800,557	78,889	114,250	21,619
2015	1,958	50	979	2,730,721	2,655,907	74,814	108,349	20,502
2016	1,857	50	929	2,590,015	2,519,055	70,959	102,766	19,446
2017	1,762	50	881	2,456,883	2,389,572	67,312	97,484	18,446
2018	1,671	50	836	2,330,909	2,267,048	63,861	92,485	17,500

2. Determination of baseline emissions from thermal energy production

$$BE_{thermal,y} = ET_{LFG,y} \cdot CEF_{therm,BL,y}$$

$$ET_{LFG,y} = M_{hotwater} \cdot C_{water} \cdot (T_{avg,hotwaer} - T_{avg,feedwater})$$

According to the boiler specifications, the outputted hot water is expected to be 95℃, and the fed water to be 15℃.
Where:

$M_{hotwater}$	Mass of hot water, in tonnes	See Table 25~27 in the above section
$T_{avg,\ hotwater}$	Average temperature of hot water,, in ℃	90*
$T_{avg,feedwater}$	Average temperature of feed water, in ℃	15
C_{water}	specific heat capacity of water, in TJ/（t·℃）	4.18e-6

*: It is estimated by the project owner that the actual temperature of hot water which has been delivered to end users will be about 90℃ due to the transportation heat losses.

$$CEF_{ther,BL,y} = \frac{EF_{coal,BL}}{\varepsilon_{boiler} \cdot NCV_{coal,BL}}$$

According to the methodology, the energy efficiency of the boilers used in the absence of the project activity to generate the thermal energy can be conservatively estimated as 100%.

ε_{boiler} =100%

According to Table 2.1, Volume 2, 2006 IPCC Guidelines for National Greenhouse Gas Inventories, the net calorific value and emission factor of are selected in a conservative way, as follows:

$NCV_{coal,BL}$ =30.5 TJ/Gg

IPCC 2006 also gives the emission factor of coal in tCO2/TJ. From Table 2.2, Volume 2, the emission factor of coal in tCO2/TJ can be selected as 89.5 tCO2e/TJ in a conservative manner.
So the emission factor of coal in tCO2/Gg can be calculated as follows:

$EF_{coal,BL}$ =89.5 tCO2e/TJ * 30.5 TJ/Gg = 2,729.75 tCO2e/Gg

So the emission reduction from thermal energy production can be obtained as follows:

Table 28 Estimated baseline emissions from thermal energy production

Year	Baseline emissions from thermal energy production (tCO_2e)		
	Zhaojiagou	Gaoguanling	Langshan
2009	2,681	2,182	2,725
2010	3,424	2,789	3,668
2011	3,249	2,650	3,668
2012	3,084	2,517	3,566
2013	2,927	2,392	3,381
2014	2,779	2,273	3,206
2015	2,638	2,161	3,040
2016	2,505	2,054	2,883
2017	2,379	1,953	2,735

2018	2,260	1,857	2,595

3. Determination of $PE_{EC,y}$

In line with the "*Tool to calculate baseline, project and/or leakage emissions from electricity consumption*" (version 01).

$$PE_{EC,y} = EC_{PJ,y} \cdot EF_{grid,y} \cdot (1 + TDL_y)$$

So $PE_{EC,y}$ can be estimated as follows:

	Parameter	Value		
		Gaoguanling	Zhaojiagou	Langshan
A	$EC_{PJ,y}$ (MWh)	374.2	374.2	374.2
B	EFgrid,y (tCO2e/MWh)	1.3		
C	TDL_y	20%		
D=A*B*(1+C)	$PE_{EC,y}$	584	584	584

4. Determination of $PE_{FC,j,y}$

As mentioned before, the boilers installed in the proposed project do not need fossil fuel for co-firing or start-up. But the transportation of produced hot water to the customers does lead to additional fossil fuel consumption. According to the methodology, the project emissions from fossil fuel combustion should be calculated following the "*Tool to calculate project or leakage CO2 emissions from fossil fuel combustion" (version 02).*

$$PE_{FC,j,y} = FC_{fuel,y} \cdot COEF_{fuel,y}$$

Where:

$FC_{diesel,y}$	the quantity of diesel combusted during the year y
$COEF_{diesel,y}$	the CO_2 emission coefficient of diesel during the year y

According to the information provided by the project owner, heavy duty diesel trucks will be used to transport produced hot water. A typical water transportation truck has a full load of 13 tonnes and fuel consumption of 0.3 liter per kilometer.

The quantity of diesel combusted during the year y, $FC_{diesel,y}$, can be estimated as follows:

	Parameter	Value		
A	Amount of water transported in year y (tones)	See Table 25~27		
B	Average Transportation distance (km)	Zhaojiagou	Gaoguanling	Langshan
		12	10	10
C	Full load capacity of the truck (tones)	13		
D	Average diesel consumption (l/km)	0.3		

E	diesel Density (kg/l)	0.84
F	NCV_{fuel} (TJ/Gg)	43.3
G	$EF_{CO2,fuel}$ (kgCO2/TJ)	74,800
F= A/C*B*2*D*E*F*G/1000	$PE_{FC,j,y}$	

Source: Table 1.2 & Table 2.2, 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Values are taken in a conservative way (highest values)

So the project emission from the transportation of hot water can be obtained as follows:

Table 29 Project emission from the transportation of hot water

Year	**project emission from the transportation of hot water (tCO_2e)**		
	Zhaojiagou	Gaoguanling	Langshan
2009	144	98	122
2010	184	125	164
2011	174	119	164
2012	166	113	160
2013	157	107	151
2014	149	102	143
2015	142	97	136
2016	135	92	129
2017	128	87	122
2018	121	83	116

Annex 4

MONITORING INFORMATION

Please refer to the section B.7 of this document for monitoring information.