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

CONTENTS

SECTION A. General description of project activity

A.1 Title of the project activity:

Jiaozishan Landfill Gas Recovery and Utilisation Project

Version: 05

Date: 5th Feb. 2007

A.2. Description of the project activity:

This proposed project is developed by Nanjing Yunsheng New Energy Development Co., Ltd.(hereafter referred to as NYNED), which is designed to set up a heating system using landfill gas collected from the Jiaozishan landfill. The project will supply hot water to hotels, bathhouses, and other heat consumers in Nanjing city. This will not only ensure the safety of landfill site by utilization of landfill gas resource, but also save the energy and reduce GHG emissions emission by displacing fossil fuel consumption in local enterprises. However, the proposed project just considers emission reduction from methane destroyed by boiler and flaring as conservative.

The Jiaozishan landfill is the main household waste disposal site in Nanjing. The site was put into operation in August, 1992; the design lifetime is 30 years, and averaging about 800 tonnes of household waste per day. By May 2005, the accumulated gross volume of buried and disposed waste in the landfill reached 2.8 million tonnes. The Jiaozishan landfill consists of three storage areas. The No.3 Storage Area has been closed for many years and most of the LFG was vented into atmosphere by exhaust vents. It is not technically viable for utilisation. Waste will be disposed into No.2 Storage Area and No.1 Storage Area continually. The LFG from No.2 Storage Area and No.1 Storage Area, which will be recovered and utilized by the proposed project, is vented into atmosphere. *It is estimated that the total amount of collectable landfill gas generated by No.2 Area and No.1 Area from 2007-2022 will be about 2,000 m^3/hour.* [1]

The proposed project will install 4 sets of boiler systems(3 tonne/hour for each one), which is made in Switzerland and German. Each boiler can destroyed LFG (50% mathane) 462 m^3/hour and 1848 m^3/hour in total. Taking the equipment installation and services into consideration, one flare shall be added and installed (the maximum combustive volume 2000 m^3/h), and the excess methane will be flared.

It is estimated to be 1,099,599 tonnes CO_2 over the 7 year period 2007 – 2013 , which equates to average annual emission reductions of 157,086 tonnes. The amount of collected CO_2 within the crediting period of twenty one years will total 4,808,528 tonnes, or 228,978 tonnes per year. The difference is due to the fact that the landfill is expected to generate more methane in the later years and the breakdown can be seen in Annex 3.

This project falls into the scope of the CDM priority areas presented in the *Administrative Regulations of Clean Development Mechanism of China*: recycling and utilisation of methane. The project has the following additional sustainable development benefits.

1. **Reduction of local environmental pollution** in the city of Nanjing. The project will install a heat supply system that will decrease the dependency of the city on heating systems using coal, oil or electricity. As such the heat provided will be more efficient than the alternative options and will directly reduce local pollution from the burning of fossil fuels.

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[1] Page-21 Nanjing Jiaozishan Landfill Gas Recovery and Utilization Project Feasibility Study Report

2. **Technology transfer** The project will make use of international technology (burners imported from Weishanpt in German and boilers imported from Hoval in Switzerland). The integrated system is able to utilise landfill gas that has a relatively low heat value relative to other fuels as well as adapt to the varying concentrations of methane. This project will act as a demonstration to other municipal landfill sites across China that could make use of new technologies in the reduction of global greenhouse gases.
3. **Accelerate the uptake of landfill gas recovery and utilisation in China.** Jiaozishan landfill was constructed in the early 1990s and is one of the earliest sanitary landfills; it represents a typical medium sized landfill in China. Projects to utilise landfill gas in China have not been economically viable in recent years and the CDM presents an opportunity for energy generation from landfill gas sites a real investment opportunity. This project will be a good demonstration for other medium and/or small 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.
4. **Improvements to safety and the site environment.** The project will reduce danger from fire or explosion on the landfill by recovering the gas as well as decreasing the odours on site.

In summary the Jiaozishan project will not only benefit the global reduction of greenhouse gas emissions, but it will also facilitate technology transfer and landfill management experience to China. Additionally the project will improve impacts of the landfill site and current energy systems on the local environment thus facilitating local sustainable development.

A.3. Project participants:

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)	Nanjing Yunsheng New Energy Development Co., Ltd.	No
United Kingdom of Great Britain and Northern Ireland	CAMCO International Ltd.	No

Project Owner and Developer:

Nanjing Yunsheng New Energy Development Co., Ltd, with its registered fund of RMB 10 million, noticed the good potential on investment opportunity in renewable energy and new energy. With extensive study and research, the company makes landfill gas utilization their first investment in the renewable energy field. With its own funds and a bank loan, Nanjing Yunsheng New Energy Development Co will build and operate the project with technical support from the Southeast University who have design expertise in landfill and also the Jiangsu Institute of Geological Exploration and Design Engineering which is experienced in landfill gas collection equipment.

Project Participant: Camco International Limited (CAMCO)

CAMCO International Limited (CAMCO) is developing the CDM aspects of the Project activity.

A first-mover in the rapidly emerging sector of greenhouse gas emissions trading, CAMCO International draws on over 20 years experience in sustainable energy project development worldwide and on over 6 years experience in JI and CDM project development. CAMCO is leveraging this experience to assist partners in optimising opportunities and in overcoming risks associated with securing and developing carbon assets.

CAMCO is now engaged on a growing portfolio of CDM and JI projects from all around the world. Project sponsors in Bulgaria, Poland, China and East Africa have recognised the benefits of working with CAMCO to secure and maximise opportunities presented by new international emissions trading markets. CAMCO is now a recognised industry leader with a growing international reputation.

Detailed contact information of project participants can be found 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.:

Jiangsu Province

A.4.1.3. City/Town/Community etc:

Dou County and Jiangning district of Nanjing City

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

The proposed project is located in the Jiaozishan landfill in Dou county, 15 miles from the urban centre of Jiangning District, eastern Nanjing City. The landfill site lies in a hilly region, with a total area of 280,000 m^2, a total capacity of 6,200,000 m^3 available for 5,500,000 tonnes waste. Figure 1 below shows the geographical location of the project site relative to the city of Nanjing.

Figure 2 provides detail on the layout of the landfill site and shows the living area, entrance area, landfill area, leachate pond, surface water deposition pond, sewerage treatment factory, and other auxiliary facilities.

The site is divided into three cells. Cell Number 3 is full and no more waste goes to this area and as such has been closed. Cell Number 2 will stop being used at the beginning of 2006 and Cell Number 1 will be put into operation. To date approximately 2,900,000 m^3 of waste has been landfilled in cell 2 and 3. The proposed heat supply plant will be located in the south of the number 3 storage area, separated from number 2 storage area by a road.

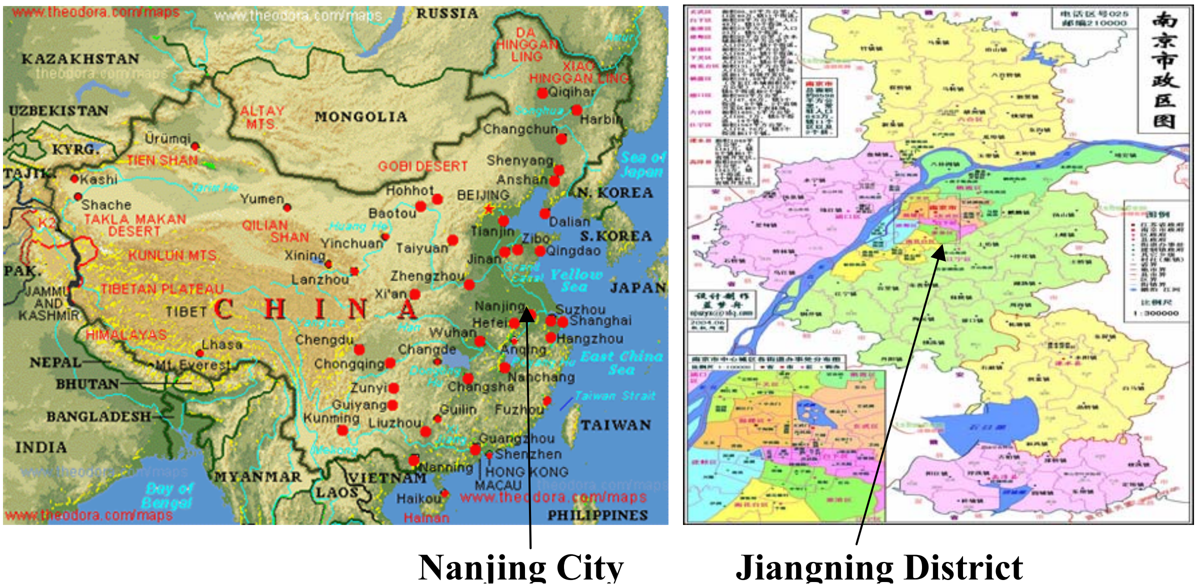

Figure 1 Geographical location of the Jiaozishan landfill

Figure 2 Location of the Jiaozishan Landfill Gas Heating Plant

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

Sectoral Scope 13: Waste Handling and Disposal

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

The Jiaozishan landfill gas project covers landfill gas collection, landfill gas pre-treatment, heat generation and heat transmission and distribution. The landfill gas will be capture and piped to the pre-treatment system, which will remove moisture and impurities from the landfill gas, under pump pressure.

Subsequently the gas will be delivered to the heat generation system.

To meet the requirements for environmental protection, fire protection, and boilers' service, the project will be equipped with a flare and a burner for combustion of excess landfill gas quantities. An overview of the system is presented in Figure 3 below and each step is described in more detail below.

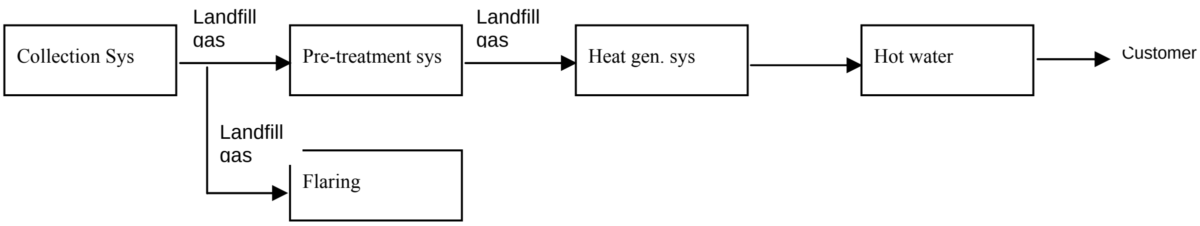

Figure 3 Work flow of landfill gas heating

Landfill Gas Collecting System:

The landfill gas collecting system is a gas transportation network, consisting of gas collecting wells, lateral gas collecting sub-pipes and a main pipe, which cover all of the landfill. The landfill gas collected from the gas wells will be delivered to the main pipe through sub-pipes. The operating pressure of the gas collecting system will be achieved with fans, thus ensuring the landfill gas to be continuously collected from the gas wells. A digital metering system will be installed on the pipes, for real time measurement and registration of data, such as: flow rate, temperature, pressure, etc. There will be an electronic monitoring system to record.

Pre-treatment System:

The pre-treatment system will ensure that the landfill gas meets the following operational standards prior to delivery to the heat generation system or flare:

- Stable gas feeding pressure (50-200mbar),
- Relative humidity ≤80%
- Gas temperature at outlet of 10-50 ^{0}C
- Filtration of particulates above 3μm),
- Pumped flow rate of 2000 m^3/h.

Landfill Gas Flare:

All excess landfill gas will be automatically delivered to the flare for combustion. The flare will be designed and constructed with a maximum capacity of 2000 m^3/hr and a centrifugal blower will be installed at the inlet of the flare. The flare burner will be equipped with an automatic safety switch, an electronic flow meter and other measuring devices in order to monitor the whole combustion process.

Boilers and auxiliary equipment:

In accordance to the expected landfill gas volume and methane concentration, and in order to ensure reliability of landfill gas combustion, imported gas boilers have been selected with nominal steam generation capacity of 3000kg/h and 0.6-1.0 MPa operating pressure.

Steam hot water heater and auxiliary equipment:

In accordance with the steam characteristics below the capacity of the boiler will be 3-4.5MW

- Flow rate = 3 t/h
- Pressure = 0.4MPa
- Seam temperature at the inlet of the hot water heater = 158 ^{0}C
- Water temperatures = 15 ^{0}C at the inlet and 95 ^{0}C at the outlet

The boiler will be equipped with electrical control circuit, water pump, temperature controller and pressure meter.

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

The total CO_2e emission reductions of this project during the first seven-years crediting period (2007-2013) is estimated to be 1,099,559 tonnes, with an annual average of 157,079 tonnes CO_2e.

Years	**Annual estimation of emission reductions in tonnes of CO_2 e**
2007	108,264
2008	136,165
2009	147,691
2010	159,275
2011	170,844
2012	182,620
2013	194,700
Total estimated reductions (tonnes of CO_2e)	**1,099,559**
Total number of crediting years	21 years
Annual average over first crediting period of estimated reductions (tonnes of CO_2e)	157,079

A.4.5. Public funding of the project activity:

There is no public funding from Annex I Parties for the proposed project.

SECTION B. Application of a baseline and monitoring methodology

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

Methodology
The version 5 of ACM0001--"Consolidated baseline methodology for landfill gas project activities"

Tool
The version 2 of the "Tool for the demonstration and assessment of additionality"

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

In accordance with the consolidated Baseline methodology (ACM0001), 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; or
b) The captured gas is used to produce energy (e.g. electricity/thermal energy), but no emission reductions are claimed for displacing or avoiding energy from other sources; or
c) The captured gas is used to produce energy (e.g. electricity/thermal energy), and emission reductions are claimed for displacing or avoiding energy generation from other sources. In this case a baseline methodology for electricity and/or thermal energy displaced shall be provided or an approved one used, including the ACM0002 "Consolidated Methodology for Grid-Connected Power Generation from Renewable". If capacity of electricity generated is less than 15MW, and/or thermal energy displaced is less than 54 TJ (15GWh), small-scale methodologies can be used.

In the case of the Jiaozishan Landfill Gas Project the captured gas is being used for heating in Nanjing city and no emission reductions are being claimed for displacing or avoiding energy from other sources. This project will indeed be a combination of a) and b) above. Therefore the consolidated baseline methodology (ACM0001) will be taken as the baseline methodology of this project.

According to the consolidated Baseline methodology ACM0001, it will be used in conjunction with the consolidated monitoring methodology.

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

The whole project boundary is shown in Figure 4 Below. The project boundary includes the landfill site, collection and utilization system, also the transport systems.

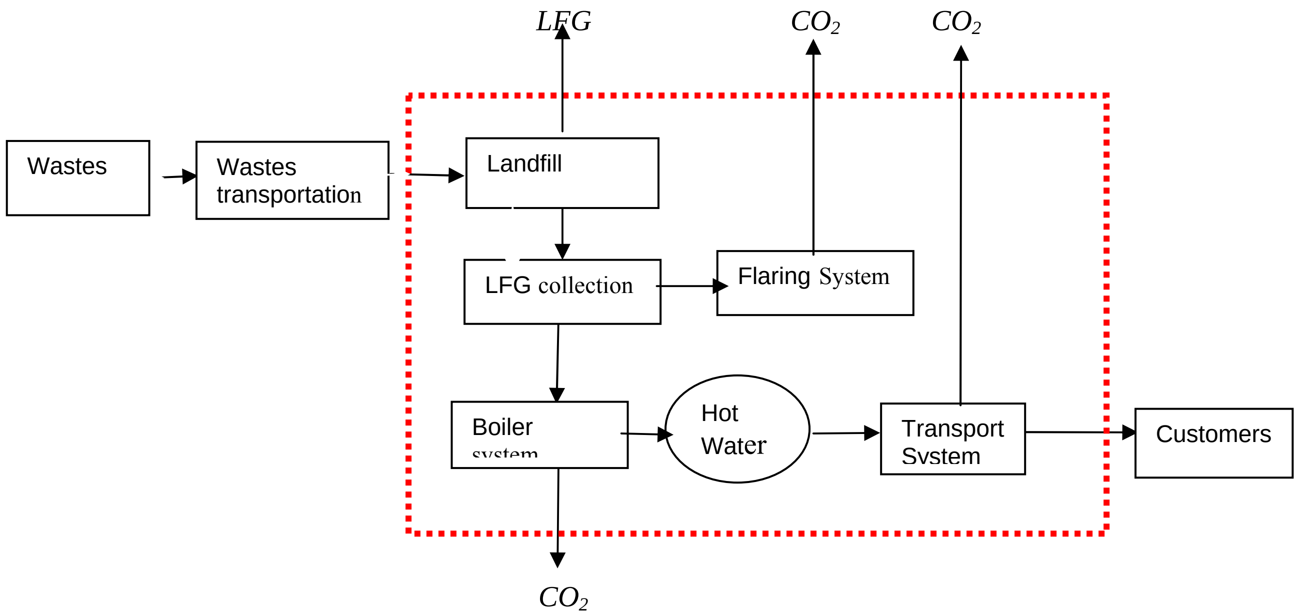

Figure 4 Project Boundary

The project activity and sources of GHG emission within the project boundary include:

	Source	Gas	Included ?	Justification / Explanation
Baseline	Emissions from decomposition of waste at the landfill site	CO_2	Excluded	CO_2 emissions from the decomposition of organic waste are not counted as they would be emitted anyway.
		CH_4	Included	Main source of emissions in the baseline.
		N_2O	Excluded	Excluded for simplification. This is conservative.
Project Activity	On-site fossil fuel consumption due to the project activity	CO_2	Included	The project will utilise diesel in the transportation of hot water.
		CH_4	Excluded	Not relevant
		N_2O	Excluded	The quantity is negligible and it is excluded
	Emissions from on-site electricity use	CO_2	Included	The project will utilise electricity from the East China Power Network for operation.
		CH_4	Excluded	Not relevant
		N_2O	Excluded	The quantity is negligible and it is excluded

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

According to the *Criterion of Sanitary Technological landfilling for Household Waste,* issued and implemented in 2004, all landfills are required to set up effective facilities for LFG collection and venting, but there are no compulsory requirements for utilising LFG. Therefore, apart from few exceptions, most of landfills in China emit LFG into atmosphere without any treatment.

In accordance with the methodology the project is consistent with paragraph 48b of the CDM Modalities and Procedures that states that the baseline methodology uses the approach of the “Emissions from a technology that represents an economically attractive course of action, taking into account barriers to investment.”

As set out in the methodology, the Tool for the Demonstration of Additionality has been applied in a transparent and conservative manner to show that the project requires assistance from the CDM in order to go ahead with the investment.

The baseline scenario is shown to be the continued use of the landfill site for waste and the venting of landfill gas.

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):

This section sets out the steps that are applied in the Additionality Tool according to the project activity.

Step 0: Preliminary Screening based on the starting date of the project activity

On 27th-28th 2004, the project owner participated a meeting in Beijing called "Sino-Italian Workshop on LFG Recovery and Utilization CDM Projects in China". From this meeting, the project owner knew that *CDM is one of the international cooperation mechanisms under the Kyoto Protocal. The developed countries will provide financial and technical assistance to implement GHG emission reduction projects in the developing countries to help them achieving sustainable development and meanwhile assist the developed countries to reduce their GHG emissions.*[2]

On May 2005, NYNED and the administrative office of landfills for Nanjing City entered into an agreement to jointly exploit Jiaozishan landfill gas utilization project. According to the agreement, NYNED would take charge of the CDM application and being responsible for project construction and operation and control of the facilities, while the administrative office of landfills of Nanjing city would assist NYNED to complete CDM affairs. What's more, CDM revenue was seriously considered in the decision to proceed with the project activity according to the agreement.

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

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

According to the investigation on the treatment of LFG in landfills, in the absence of the Proposed Project, the alternative baseline scenarios include:

Alternative 1: The landfill operator would continue the current business as usual practice of not collecting and flaring LFG from the waste management operations. The methane in LFG is vented into the atmosphere.

Alternative 2: The landfill operator would invest in a LFG collection system as well as a flaring system.

Alternative 3: The landfill operator would invest in a LFG collection system as well as an energy production system (to produce electricity, thermal energy), but not develop the project as a CDM project.

For Alternative 1:
This would mean that landfill gas would not be collected and either flared or utilised for energy purposes. Under current Chinese legislation only new landfill sites are required to manage their landfill gas emissions and it would therefore be expected that the landfill would continue to produce methane through the anaerobic decomposition of the organic fraction of municipal waste. This scenario would be expected to continue throughout the project lifetime and beyond.

[2] Sino-Italian Workshop on LFG Recovery and Utilization CDM Projects in China Meeting Minutes Dec.28, 2004

For Alternative 2:

To invest in construction and operation of LFG collection and flaring systems, which will cost hundreds of thousands of US$ without any revenue. Without mandatory regulations on construction and operation of LFG collection and flaring system and related penalties, without certain amount of financial support, there is no incentive for the landfill operator to do so.

For Alternative 3,

Compare to Alternative 2, there is a production system in Alternative 3, which will bring revenue. Currently, possible LFG utilization technology options in China are mainly LFG power generation or thermal energy supply. Application of each of these technologies means an initial investment of millions of US$. Based on cost-benefit analysis of these technologies without any financial support, incentive policies or subsidy, IRR for each technology is negative (Refer to B5). The alternative 3 is not economically attractive for landfill operator and not plausible.

Sub-step 1b：Enforcement of applicable laws and regulations：

According to updated *Criterion of Sanitary Technological landfilling for Household Waste* issued in 2004 (CJJ17-2004), new built landfills are required to,

Set up effective facilities for LFG evacuation and transportation, to strictly forbid undiscovered gas gathering and moving for avoiding fire and explosion. Take action to actively evacuate gas and gather it for flaring, when the landfill is not in condition of utilizing landfill gas. Those old landfills which are not safe and stable should be built up with effective facilities for LFG evacuation and treatment.

In the case of the Jiaozishan landfill, the site was constructed in 1992 and at that time, there were no standards for LFG collection and utilisation issued in China. The Jiaozishan landfill is not obliged to implement the changes set out in the new law. The three alternatives identified above are therefore all in line with the current laws and regulations. The Jiaozishan landfill has been used for 13 years and it is the responsibility of the government of Nanjing City is to ensure its safe operation. The Nanjing Municipal Government does not have a budget to invest in landfill gas capture and utilisation technologies either at present or in future budgetary plans. This means that without the support of the CDM, the investment cannot be undertaken. Additionally given that the project is considered to be fairly high risk due to uncertainties over the methane production of the site. It is for these reasons that the legislation is not being enforced for existing landfills in China and projects are not viable without the support of the CDM. Thus, alternative 2 and 3 are not a feasible choice for project owner or investors.

Therefore, the alternative 1 is the most credible and plausible method for LFG disposal. And the methane in LFG will be vented into atmosphere in the baseline scenario. No investment and revenue will be generated.

Step 2：Investment analysis

Sub-step 2a：Determine appropriate analysis method

There are three analysis methods set outin the “Tool for Demonstration and Assessment of Additionality” to demonstrate that the proposed project does not meet economic and financial criteria to go ahead without the CER revenue.

The proposed Project generates financial and economic benefits through the sales of hot water other than CDM related income. Therefore the simple cost analysis (Option I) couldn't be taken. And the investment comparison analysis (Option II) is only applicable to projects where alternatives should be similar investment projects. so comparative analysis(Option II) can be conducted. Then the benchmark analysis (Option III) is left, and this option is just fit to the project situation. The proposed project will use option III: benchmark analysis method.

Sub-step 2b：Option III Apply benchmark analysis

In this project, internal Rate of Return IRR is used as financial indicator for comparison.

Benchmark Chosen

On May, 2005, the interest rate of 5 years depositions in local business banks of China was 3.60% and the lending rate was 5.85%. The upper limit line of public bidding invitation of national debt was 4.50%. The internal rates of return of the Chinese stock market and innate funds were 11% and 13% respectively.

In the electric power industry in China, the internal rate of return for conventional fossil fuel power plants, especially preliminary burthen electricity plants, is about 8% because of the stable incomes.

Landfill gas projects that provide energy either in the form of heat or electricity are new to China and their deployment is still rather limited.

The uncertainties over the fuel supply when compared to conventional energy investments add an additional level of risk to the investment. The project suffers from an increased risk on the fuel supply side as well as additional risks associated with the application of new technology and these risks must be considered when applying a benchmark IRR for this project.

Additionally the project is located in one of the most developed regions in China, Nanjing City, Jiangsu Province. This means that local investors are likely to require far higher returns on their investments than would be the case for China as a whole.

A benchmark determined by the MOA in China for biogas technologies has been set at an IRR of 12.5%[3]. Given the technology and fuel supply risks of such projects this should be considered a conservative benchmark for this project.

Sub-step 2c：Calculation and comparison of financial indicators

(1) Basic parameters for calculation of financial indicators

Based on the above-mentioned benchmark, the calculation and comparative analysis of financial indicators for the proposed project are carried out as follows.

Table 1 Parameters of the financial analysis

Items	Unit	Value	Reference
Total Investment	Yuan	22,566,000	Feasible study report
Fixed Assets	Yuan	14,990,000	Feasible study report

[3] MOA of China/US DoE expert panel, "Biogas Energy Conversion Technological Development and Evaluation", China Environment Publishing House, 1998

Depretiation Rate	%	5%	Feasible study report
Loan(s) Amount	Yuan	12,200,000	Feasible study report
Interest rate	%	6.00%	Feasible study report
Annual Operational and Maintenance Fee	Yuan	1,100,000	Feasible study report
Labor Cost Fee	Yuan	460,000	Feasible study report
Price for electricity consumed from East China Grid	Yuan/KWh	0.7	Feasible study report
Cost for Electricity consumed	Yuan/year	907,200	Feasible study report
Cost for Water consumed	Yuan/year	2,052,864	Feasible study report
Fee for Administration	Yuan/year	540,000	Feasible study report
Cost for sales(Transports)	Yuan/year	7,238,400	Feasible study report
Price For Selling Hot Water	Yuan/tons	**34**	Agreement between Project owner and user
Annual hot water sales	tons/year	466550	Feasible study report
Income tax	%	33%	Feasible study report
Expected CERs Price	$/tCO2e	6	Assumption
Average Emission Reduction	tCO2e/y	157,079	PDD
CERs crediting time	Year	7×3=21	PDD

Note：

1、 Annual hot water sales = capacity of boilers × operating hours per year × efficiency of boiler × heat exchange coefficient , (from project assessment report）

2、 It assumes that the project will install 4 sets of boilers and under proper operation.

(2) Comparison of IRR for the proposed project and the financial benchmark

In accordance with the benchmark analysis (Option III), the proposed project will not be considered as financially attractive if its financial indicators (Project IRR) are lower than the benchmark rate.

Table 2 Financial indicator of the proposed project

Items	Unit	Without income from CERs	Benchmark
Prject IRR	%	6.15%	12.5%

Sub Step 2d：Sensitivity Analysis

The purpose of the sensitivity analysis is to examine whether the conclusion regarding the financial viability of the proposed project is sound and tenable with those reasonable variations in the assumptions. The investment analysis provides a valid argument in favour of additionality only if it consistently supports (for a realistic range of assumptions) the conclusion that the project activity is unlikely to be the most financially attractive or is unlikely to be financially attractive.

Three financial parameters including: Total Investment, Sales (Transports) Cost and price of Hot water were identified as the main variable factors for sensitive analysis of financial attractiveness. Their impacts on Project IRR were analyzed in this step.

For detailed results of sensitive analysis of the three indicators, please see Table 5.
Financial analyses were performed to assess what the impact on the Project profitability would be by altering each of these parameters by 10%. The impact on the project IRR is as follows:

Table 3 Sensitivity Analysis

Items	IRR
Original	**6.15%**
Case 1: Reduce total investment 10%	**7.34%**
Case 2: Reduction in sales(Transports) cost 10%	**9.50%**
Case 3: Increase the price of Hot water 10%	**13.24%**
Case 4: Reduce the price of Hot water 10%	**-2.27%**
Benchmark	**12.5%**

As shown from Table 5 above, For Case 1 and Case 2, even if the total investment and sales cost are reduced by 10%, the project IRR is still below the benchmark, the project is not financially contractive as well.

From Case 3 and Case 4, Can be seen that the price of hot water is very sensitive. Case 3 will be over the benchmark, while Case 4 is a negative IRR. The price is determined in agreement between project owner and hot water user once a year, it exists the possibility that the price will increase 10%, but uncertainty among LFG collection and operation condition of the project can directly influence the output of hot water. The project owner lacks experience in LFG collection and LFG combustive boiler operation, and the operational risk for LFG utilization project is high (detailed description in Step 3). While the output of hot water per year identified in FSR is an ideal condition and not conservative considered. Thus, the proposed project is still financially unattractive.

Except for lowly financial attraction, the proposed project would meet many barriers in the implementation process. The detailed analysis is in Step 3. Barrier analysis

Step 3. Barrier Analysis

Sub-step 3a. Identify those barriers that would prevent the implementation of type of the proposed project activity

This step is used to demonstrate that the project faces real barriers that would prevent the implementation of the project without the CDM. The *National Action Plan for Recovery and Utilization of Landfill Gas* approved by SEPA, NDRC, MOF, MOC, MOST, STEC etc. in 2002 and publicized by SEPA [4] cites four main barriers to implementation of landfill gas recovery and utilization as follows:

[4] http://www.china5e.com/news/huanbao/200210/200210240047.html

1. Technology: There is very little experience in landfill gas collection equipment manufacture, installation and operation in China.
2. Methodology: No clear methods for collecting and destroying methane emissions exist for China and in particular financing methods.
3. Policy & Financing: All of the municipal waste treatment costs are borne by the city government, who do not have the capacity to implement and finance the projects.
4. Organisational: The government departments and the enterprises, which are in charge of waste collection and landfill management, are not well coordinated and the opportunities for investment cooperation are limited.

For the Jiaozishan landfill there principal barriers to project implementation are investment, technology and operation and management. These are presented below.

Technology barriers

The proposed project is the first kind in China, which is to utilize LFG to heating boilers for hot water. Due the fact that the methane content of the LFG from the landfill averages between 40% and 50%, the project is forced to procure boilers from abroad that can safely operate in on 30%-70% methane gas. No such boiler is currently available in China. Therefore, the project is ordered Swiss Boilers from Hoval at a cost of roughly 5 times greater than domestically procured boilers. The need to import equipment means that the project faces both increased capital and increased maintenance costs as international travel will be required for the management team of the Nanjing landfill to be properly trained.

As this technology will be operated for the first time in China and by a landfill with little experience in landfill gas recovery and utilisation, there will be increased costs to the owner in terms of equipment maintenance and training. Given the marginal economic returns on the project, the technology risk and the increased risk and investment in terms of training gives lessens the incentive of the project owner to invest in the project.

Marketing Risk

The price of hot water supplied by the proposed project is lower competitive than that of it supplied by fossil fuel boilers in Nanjing market. The reason is uncertainty of hot water supply and high transport cost.

From 2005 to 2006, the project owner negotiated with 20 consumers for determining the hot water price. The consumers considered it was more stable to use hot water heated by fossil-fuel boilers than LFG combustive boilers due to LFG collection uncertainty and low confidence to project owner by lack of project operational experience. And with the low price and no CDM revenue the project owner moved its investment determination. In the middle of 2005, with the confidence from registered CDM project, Nanjing Tianjingwa LFG to electricity project, the project owner continued to negotiating.

According to the current supply contract[5], the negotiating price is 25 RMB per ton, which is higher than hot-water suppliers in Nanjing. Since the landfill is located 15 km away from Nanjing city, the price of hot water supplied by the proposed project should be considered the cost of transport fee from landfill to Nanjing city. This will add an additional 10 RMB per ton.

Convinced by the local government and project owner by supporting an GHG emission reduction project, Industrial enterprises in the Nanjing area are willing to accept the price. Nevertheless, the contracts will

[5] Hot Water Supply and Sales Contract of Nanjing Landfill, 12 April 2006

be resigned once a year, this will bring considerable risk, which it is possible that they are not willing to renew their contracts in the upcoming years.

Without the CDM, all revenue from this project is dependent on sales of hot water to the city of Nanjing. However, compared with competitors, hot water sales face a number of barriers including uncertainty of output, higher cost price and unstable contract. The project owner can not overcome the barriers.

Sub-step 3b.Show that the identified barriers would not prevent the implementation of at least one of the alternatives (except the proposed project activity)

The identified reasonable and credible alternative to the proposed project is:
The landfill operator would continue the current business as usual practice of not collecting and flaring LFG from the waste management operations. In this scenario the LFG will not be collected and utilized for energy purpose. Methane generated by the landfill will be emitted. The project owner will not faced barriers referred above.

Step 4：Common practice analysis
Sub-Step 4a – Analyze other activities similar to the proposed project activity.

China has 700 registered landfill sites but only 10 of them have installed gas recovery and utilisation systems[6]. According to the *National Action Plan for Recovery and Utilization of Landfill Gas* published in December 2001[7], “at present, in China the municipal refuse is disposed using the technology of traditional landfill, without consideration of recovery and utilization of landfill gas. It is estimated that the annual quantity of municipal refuse filled is about 50 million tons. Almost all landfill gas is emitted to the atmosphere openly”.

Since the time that this work was undertaken only some newly built landfill sites have adopted landfill gas utilisation and 3 projects that were supported by the GEF as demonstration projects (Nanjing Shuige, Anshan and Maanshan pilot projects). Additionally all of the projects that have been implemented have been done for the generation of power and cannot therefore be compared directly with the Nanjing Jiaozishan Landfill Gas Recovery and Utilisation Project, which is the first of it’s kind in China.

Given the limited experience with landfill gas recovery and utilisation in China, the CDM is being promoted as a financing tool to enable these projects to go forward[8] and as such there are now 3 projects registered with the CDM Executive Board[9].

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

Landfill gas recovery and utilisation in China, for heat or power, cannot be considered common practice, since there are so few in operation and those that are tend to have been grant financed through the GEF or financed through the CDM. As discussed above, the Jiaozishan Landfill Gas Recovery and Utilisation

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[6] Lu Guoqiang, State Environmental Protection Administration, China. March 2006.

[7] As part of study conducted by the UNDP/GEF and the China State Environmental Protection Authority in 2001

[8] Landfill Gas Recovery and Utilization CDM Project Development in China, China State Environmental Protection Authority, http://cdm.ccchina.gov.cn/UpFile/File542.PDF

[9] Anding Landfill Gas Recovery and Utilisation Project, Meizhou Landfills Gas Recovery and Utilisation as Energy and Nanjing Tianjingwa Landfill Gas to Electricity Project.

Project is the first project kind in China to solely be producing heat and cannot be compared with other landfill gas recovery and utilisation projects that generate power.

Step5: Impacts of CDM registration

The IRR of the proposed project will reach 35.65% if taking the CER income ($6/ tCO2) into consideration. This will greatly improve this project's financial situation, and ensure good operation and project performance. Additionally, given that the CER income is in a foreign currency this can also mitigate the risk of the project costs increasing due to fluctuation of exchange rates, as all equipment employed in the proposed project activity are imported. And it also can help project owner to reduce the marketing risk, keep the expected returns.

If the proposed project cannot be registered as a CDM project activity by EB, then (1) because the income from CDM is a significant supplementary income source for the proposed project, lack of income from CDM would lead to lower competence of returns on proposed project, further cause the crisis of currency flow, or might even cause the failure of the proposed project; (2)the owner of the project might postpone or give up the proposed project due to the high technological risk due to lack of know-how in operation, maintenance and training.

The proposed project activity would not occur in the absence of income from CDM, the owner will keep the existing infrastructure and not collect, evacuate and flare LFG. As stated in step 2 and step 3, the proposed project has strong additionality and has the potential to reduce GHG emissions greatly. If the proposed project cannot be registered as CDM project activity, the emission reduction would not be achievable. The analysis above can demonstrate that the environmental benefit, investment and technological aspects of the proposed project are consistent with the additionality assessment regulations of CDM. The analysis of additionality above provides sufficient and necessary evidence, which could demonstrate that approval of the proposed project to be registered and implemented as CDM project can help overcome the barriers that prevent the LFG collection and utilization.

B.6. Emission reductions:

B.6.1. Explanation of methodological choices:

According to the baseline methodology ACM0001 version 4, the emission reductions caused by the project can be calculated by following formula:

1. The total emission reductions equation

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

Where:

- ER_y: greenhouse gas emission reduction achieved by the Project activity during a given year "y" (t CO2e).
- $MD_{project,y}$: amount of methane actually destroyed/combusted during the year "y" (tCH4).
- $MD_{reg,y}$: amount of methane that would have been destroyed/combusted during the year "y" in the absence of the Project activity (tCH4).
- GWP_{CH4}: approved Global Warming Potential value for methane (21 t CO2e / tCH4).
- EL_y: net quantity of electricity displaced during the year "y" (MWh).
- $CEF_{electricity,y}$: CO2 emissions intensity of the electricity displaced during year "y" (tCO2e/MWh).

- *ET_y:* incremental quantity of fossil fuel, defined as difference of fossil fuel used in the baseline and fossil use during project, for energy requirement on site under project activity during the year y, in TJ.
- *$CEF_{thermal,y}$*: CO2 emissions intensity of the thermal energy displaced during year *"y"* (tCO2e/TJ).

So, the greenhouse gas emission reduction achieved by the project activities during a given year "y" (ER_y) is the difference between the amount of methane actually destroyed/combusted during that year ($MD_{project,y}$) and the amount of methane that should have been destroyed/combusted during that year in the absence of the project activity ($MD_{reg,y}$) minus the energy (ET_y) and electricity (El_y) used by the project.

2. The emission reductions of the methane destroyed by boiler and flare

The greenhouse gas emission reductions achieved by the project activity during a given year "y" (ERy) are estimated as follows:

$$(MD_{project,y} - MD_{reg,y}) * GWP_{CH4}$$

$$MD_{reg,y} = MD_{project,y} \times AF \quad (2)$$

AF	An"Adjustment Factor"(AF). In cases where regulatory or contractual requirements do not specify $MD_{reg,y}$ an "Adjustment Factor" (AF) shall be used and justified, taking into account the project

The value of AF considered by the project is 0. The reason for this is in B.6.2

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

Where

$MD_{project,y}$	The methane destroyed by the project activity during the year "y" (t)
$MD_{flared,y}$	The quantity of methane destroyed by flaring during the year "y" (t)
$MD_{electricity,y}$	The quantity of methane destroyed by generation of electricity during the year "y"(t)
$MD_{thermal,y}$	The quantity of methane destroyed for the generation of thermal energy during the year "y"(t)

The project doesn't destroy methane by electricity generation, so the methane destroyed (*$MD_{total,y}$*) during crediting time is determined by monitoring the quantity of methane actually gas used for heating boilers($MD_{thermal,y}$) and flared($MD_{flared,y}$).

$$MD_{flared,y} = LFG_{flared,y} \times w_{CH4,y} \times D_{CH4} \quad (4)$$

$$MD_{thermal,y} = LFG_{thermal,y} \times w_{CH4,y} \times D_{CH4} \quad (5)$$

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

Where

$LFG_{flared,y}$	The quantity of landfill gas flared (m^3) during the year "y", It is determined by monitoring the flow meter.
$LFG_{thermal,y}$	The quantity of landfill gas combusted for boiler (m^3) during the year "y", It is determined by monitoring the flow meter.
$w_{CH4,y}$	Proportion of CH_4 in landfill gas. It is determined by monitoring the component analyzer.
D_{CH4}	Density of CH_4. According to the methodology, at a normal temperature and atmospheric pressure(0℃，1013 Pa), the density of CH4 is 0.0007168 tCH_4/m^3CH_4。
$MD_{total,y}$	The quantity of methane collected (t)。
$LFG_{total,y}$	The quantity of landfill gas collected (m^3)。

3. The project emission due to electricity comsumed by the project

$$EL_y = EL_{EX,LFG} - EL_{IMP} \quad (7)$$

Where:

- $EL_{EX,LFG}$: Net quantity of electricity exported during year y, produced using landfill gas, in megawatt hours (MWh).
- EL_{IMP} : Net incremental electricity imported, defined as difference of project imports less any imports of electricity in the baseline, to meet the project requirements, in MWh.

In the case of the proposed project, no electricity is generated by LFG, while the power consumed by the fans, pumps and other auxiliary equipments is imported from East China Grid. So the emission factor ($CEF_{electricity}$) of East China is calculated and ex-ant.

$CEF_{electricity}$ is calculated as a combined margin (CM) factor consisting of the weighted average of the operating margin (OM) factor and the build margin (BM) factor, according to the three steps outlined below, available from the Chinese DNA. This is conservative since published emissions factors are higher than those previously validated for regional power grids in China[10] and as such the emission reductions will be lower.

Step1: Calculate the Operating Margin, $EF_{OM,y}$

According to the approved consolidated baseline methodology ACM0002, "Simple OM" method is used for calculating Operating Margin emission factor ($EF_{OM,y}$). The equation is given as follows:

$$EF_{OM,simple,y} = \frac{\sum_{i,j} F_{i,j,y} \cdot COEF_{i,j}}{\sum_{j} GEN_{j,y}} \quad (8)$$

Where:

- $F_{i,j,y}$ is the amount of fuel i (in a mass or volume unit) consumed by province j in year(s) y,

[10] For example see the Fujian Zhangpu Liuao 30.6 MW Wind Power Project, where a combined margin of 0.737 tonnes CO_2/MWh rather than the 0.866 tonnes CO_2/MWh calculated by the DNA for the East China Power Network.

- $COEF_{i,j\,y}$ is the CO2 emission coefficient of fuel i (tCO2 / mass or volume unit of the fuel), taking into account the carbon content of the fuels used by province j and the oxidation percent of the fuel in year(s) y, and
- $GEN_{j,y}$ is the electricity (MWh) delivered to the grid by province j.

The CO_2 emission coefficient $COEF_i$ is obtained as

$$COEF_i = NCV_i \cdot EF_{CO2,i} \cdot OXID_i \qquad (9)$$

where:

- NCV_i is the net calorific value (energy content) per mass or volume unit of a fuel i and is specifically given by the country.
- $OXID_i$ is the oxidation factor of the fuel (IPCC default values), and
- $EFCO_{2,i}$ is the CO2 emission factor per unit of energy of the fuel i (IPCC default values).

In addition, in the case that the grid has net imports and the specific power plant(s) is known, the emission factor of the imported power from the specific power plant(s) should be used. In the case of unknown specific power plant(s), average emission factor of exporting grid should be used.

The OM is determined ex-ante and fixed for the crediting period of the project.

Step 2: Calculate the Build Margin, $EF_{BM,y}$

According to the approved consolidated baseline methodology ACM0002, the Build Margin emission factor ($EF_{BM,y}$) is calculated as the generation-weighted average emission factor (tCO_2/MWh) of a sample of power plants *m*, as follows:

$$EF_{BM,y} = \frac{\sum_{i,m} F_{i,m,y} \times COEF_{i,m,y}}{\sum_{m} GEN_{m,y}} \qquad (10)$$

Where:

- $F_{i,j,y}$ is the amount of fuel i (tce, tonnes of standard coal) consumed by power plants m in year(s) y,
- $COEF_{i,j\,y}$ is the CO_2 emission coefficient of fuel i (tCO_2/tce), taking into account the carbon content of the fuels used by power plants m and the oxidation percent of the fuel in year(s) y, and
- $GEN_{j,y}$ is the electricity (MWh) delivered to the grid by power plants m.

The Methodology has two options for calculating BM:
1) Calculate the Build Margin emission factor $EF_{BM,y}$ ex-ante based on the recent 3 years available data at the time of PDD submission.
2) For the first crediting period, the Build Margin emission factor $EF_{BM,y}$ must be updated annually *ex-post* for the year in which actual project generation and associated emissions reductions occur. For subsequent crediting periods, $EF_{BM,y}$ should be calculated *ex-ante*, as described in option 1 above. The result of $EF_{BM,y}$ is based on *ex-ante* calculated according to option 1, and no *ex-post* monitoring and updating is needed.

However, in China, it is very difficult to obtain the data of the five existing power plants built most recently or the power plants capacity additions in the electricity system that comprise 20% of the system generation (in MWh) and that were built most recently because these data are considered as confidential business information by the plant owners. Taking notice of this situation, EB accepts the following deviation in methodology application[11]:

1) Use of capacity additions during the last 1~3 years for estimating the build margin emission factor for grid electricity.
2) Use of weights estimated using installed capacity in place of annual electricity generation.

And it is suggested to use the efficiency level of the best technologies commercially available in the provincial/regional or national grid of China, as a conservative proxy.

Because capacities of technologies using coal, oil and gas cannot be separated from the total thermal power generation from available statistics, the following method is used for the calculation: first, use the recent one year available energy balance data and calculate percentages of CO2 emission of power generation using solid, liquid and gas fuel in total CO2 emission. Second, calculate grid thermal power emission factors, using the percentages (as weights) and emission factors of technologies corresponding to best available technology efficiencies. Lastly, thermal power emission factor is multiplied by the percentage of thermal power in 20% newly built capacity in the grid, and the result is the Build Margin emission factor of the grid.

Steps and equations are as follows:
Step 1: calculate percentages of CO2 emission of power generation using solid, liquid and gas fuel in total CO2 emission.

$$\lambda_{Coal} = \frac{\sum_{i \in COAL, j} F_{i,j,y} \times COEF_{i,j}}{\sum_{i,j} F_{i,j,y} \times COEF_{i,j}} \quad (11)$$

$$\lambda_{Oil} = \frac{\sum_{i \in OIL, j} F_{i,j,y} \times COEF_{i,j}}{\sum_{i,j} F_{i,j,y} \times COEF_{i,j}} \quad (12)$$

$$\lambda_{Gas} = \frac{\sum_{i \in GAS, j} F_{i,j,y} \times COEF_{i,j}}{\sum_{i,j} F_{i,j,y} \times COEF_{i,j}} \quad (13)$$

Where:

- $F_{i,j,y}$ is the amount of fuel i (tce) consumed by province j in year(s) y,
- $COEF_{i,j\,y}$ is the CO_2 emission coefficient of fuel i (tCO_2 /tce), taking into account the carbon content of the fuels used by province j and the oxidation percent of the fuel in year(s) y,

Coal, Oil and Gas refer to coal fuel, oil fuel and gas fuel in the subscript set.

Step 2: calculate thermal emission factor.

$$EF_{Thermal} = \lambda_{Coal} \times EF_{Coal,Adv} + \lambda_{Oil} \times EF_{Oil,Adv} + \lambda_{Gas} \times EF_{Gas,Adv} \quad (14)$$

Where:

[11] Http://cdm.unfccc.int/Projects/Deviations.

- $EF_{Coal,Adv}$， $EF_{Oil,Adv}$ and $EF_{Gas，Adv}$ are emission factors corresponding to commercially optimal efficient power generation technology using coal, oil and gas. The specific parameters and calculation process can be seen in Annex 3.

Step 3: calculate grid Build Margin emission factor.

$$EF_{BM,y} = \frac{CAP_{Thermal}}{CAP_{Total}} \times EF_{Thermal} \quad (15)$$

Where:

- CAP_{Total} is the total newly built capacity, $CAP_{Thermal}$ is the newly built thermal power capacity.
- The BM is calculated ex-ante and fixed for throughout the crediting lifetime of the project.

Step 3: Calculate the baseline emission factor (EF_y)

The baseline emission factor (tCO_2/MWh) is calculated as the weighted average of the OM emission factor and the BM emission factor where the weights w_{OM} and w_{BM}.

$$CEF_{electricity} = w_{OM} * EF_{OM,y} + w_{BM} * EF_{BM,y} \quad (16)$$

The weighting of the OM and BM emissions factors used are the default values suggested by the methodology as follows:

w_{OM} = 0.50

w_{BM} = 0.50

Table 4 Calculation of Emission Factor

Item	OM (tCO_2/MWh)	BM(tCO_2/MWh)	CM, $CEF_{electricity}$ (tCO_2/MWh)
East China Power Grid	0.9448	0.7869	0.8659

The emission reductions from this project have been estimated ex-ante however the actual emission reductions will be monitored ex-post. Emission reductions will be claimed for the reduction of greenhouse gases through the combustion of landfill gas collected either to supply heat or through the burning of excess gases in controlled flares.

4. The project emission due to fossil fuel consumed by truck transport

Diesel used for the transportation of hot water is a kind of project emission, and the emission factor of diesel used in the project is calculated conservatively and ex-ant. As discuss with DOE, the project owner consider the project emission from fossil fuel consumed by truck transport can be calculated as follows:

$$ET_y * CEF_{thermal,y} = HW_y / HW_{truck} * COEF_D / 1,000,000 * D_{trip} \quad (17)$$

Where:

- ET_y is the total quantity of diesel consumed by the trucks in year y.
- HW_y is the total amount of hot water produced in year, y, in tonnes.
- HW_{truck} is the hot water each truck is able to transport, (8 tonnes/per truck).
- $COEF_D$ is the CO_2 emission factor in gCO2/km for Heavy Duty Diesel Vehicles.

- D_{trip} is the distance travelled for a round trip by the diesel trucks in km.

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

Some data and parameter in the formula above should be determined at validation is showed in the table below.

Data / Parameter:	GWP $_{CH4}$
Data unit:	tCO_2e
Description:	Global warming potential of methane
Source of data used:	ACM0001
Value applied:	21
Justification of the choice of data or description of measurement methods and procedures actually applied :	
Any comment:	-

Data / Parameter:	**AF**
Data unit:	1
Description:	Adjustment Factor， an "Adjustment Factor"(AF). In cases where regulatory or contractual requirements do not specify $MD_{reg,y}$ an "Adjustment Factor" (AF) shall be used and justified, taking into account the project.
Source of data used:	The proposed project feasibility study report
Value applied:	0
Justification of the choice of data or description of measurement methods and procedures actually applied :	At present, in China the municipal refuse is disposed using the technology of traditional landfill, without consideration of recovery and utilization of landfill gas. Almost all landfills do not have landfill gas recovery systems, except a few newly built landfills, and the landfill gas is emitted to the atmosphere openly.
Any comment:	According to the circumstances of the project activity.

Data / Parameter:	CEF $_{electricity}$
Data unit:	tCO_2/MWh
Description:	Calculated *ex ante* as a weighted sum of emission factors of Operating Margin and Build Margin. The emission factor is fixed throughout the crediting period.
Source of data used:	Chinese Designated National Authority
Value applied:	0.866 tCO_2/ MWh
Justification of the choice of data or description of measurement methods and procedures actually applied :	Emission factor calculated according to the methodology presented in ACM0002: "Consolidated baseline methodology for grid-connected electricity generation from renewable sources" (ACM0002/ Version 06, Sectoral Scope: 1, 19 May 2006)[12].

[12] http://cdm.unfccc.int/methodologies/PAmethodologies/approved.html

Any comment:	-

Data / Parameter:	HW_{truck}
Data unit:	tonnes/per truck
Description:	The amount of hot water for each truck
Source of data used:	Feasible Study Report
Value applied:	8
Justification of the choice of data or description of measurement methods and procedures actually applied :	The amount of hot water for each truck can be determined by the capacity of the truck, which is brought by the project owner. In order to simplified the calculation in the operational period. The top capacity (8 tons/per truck) will be used as a constant figure for conservative consideration.
Any comment:	This data is ex ant.

Data / Parameter:	$COEF_D$
Data unit:	gCO2/km
Description:	the CO_2 emission factor in for Heavy Duty Diesel Vehicles
Source of data used:	Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories (Table 1-32 on Page 1.75) of the Reference Manual (Estimated Emission Factors for US Heavy Duty Diesel Vehicles)
Value applied:	1097
Justification of the choice of data or description of measurement methods and procedures actually applied :	The figure of 1097 is from IPCC, which is the highest one among all of the emission factors for US Heavy Duty Diesel Vehicles, so it is the conservative figure. The evidence will be provided to DOE.
Any comment:	This data is ex ante.

Data / Parameter:	D_{trip}
Data unit:	km
Description:	the distance travelled for a round trip by the diesel trucks
Source of data used:	Feasible Study Report
Value applied:	30
Justification of the choice of data or description of measurement methods and procedures actually applied :	The distance from the Landfill site to the urban centre of Jiangning District, eastern Nanjing City is less than 15 kilometers and therefore a value of 30km is taken for D_{truck} .
Any comment:	This data is ex ant.

B.6.3 Ex-ante calculation of emission reductions:

The estimation of emission reduction in advance delivers as follows,

Step 1 Estimate of total amount of collected methane（$CH_{4Total,y}$）

Considering the amount of waste received by the landfill varies yearly, the estimation of the emission reduction of greenhouse gases caused by proposed project will adopt the mutation of FOD model formula of second grade in the Revised 1996 IPCC Guideline for National Greenhouse Gas Inventory , i.e. the total amount of methane production(Q_T) in present year(T) can be calculated according to the amount of methane produced($Q_{T,X}$) by the amount of waste(R_x) that filled in the landfill every year(x) after the landfill started operation.

$$Q_T = \Sigma_x Q_{T,x} = \Sigma_x k \ L_o \ R_x \ e^{-k(T-x)} \qquad (18)$$

where:

- T= present year
- x = Every year from the year when the landfill started operation to present year
- $Q_{T,x}$ = the amount of methane(tCH_4/yr) produced by the waste filled in year x in present year
- total amount of the methane generation in present year
- k = constant of methane produce rate (1/yr). The default value of methane generation rate constant was set as 0.005/yr-0.4/yr by IPCC in year 1996. According to the research on environmental engineer institute of Nanjing university, landfill gas generation Rate (K) in Jiaozishan landfill is 0.08/y.
- L_o = methane produce potentiality (tCH_4/t waste). According to the research on environmental engineer institute of Nanjing university, L_o in Jiaozishan landfill is 84 m^3/tons waste.
- R_x = the amount of waste(t/yr) filled in year X

The process for determining L_0 and k is showed in Annex 3.

$$Q_T = Sum\ Q_{T,x} \qquad (19)$$

The LFG produced by the landfill site should be estimated in the Annex 3 in details.

Table 6 Generation and Collection of the Landfill Gas

T (Year)	Yearly amount of disposal landfill R_x (T/yr)	Amount of cumulated landfill (Ts)	Amount of producing methane (m^3/hr)	Methane amount (t/yr)	Collection efficient η(%)	Amount of collecting methane (m^3/hr)	$CH_{4Total,y}$ （t/yr）
1995	147,581	147,581	0	0	0%	0	
1996	157,002	304,583	113	710	0%	0	
1997	167,023	471,606	225	1,414	0%	0	
1998	177,684	649,290	336	2,112	0%	0	
1999	189,025	838,315	446	2,803	0%	0	
2000	201,091	1,039,406	557	3,500	0%	0	
2001	213,927	1,253,333	668	4,198	0%	0	
2002	227,582	1,480,915	781	4,908	0%	0	
2003	242,108	1,723,023	896	5,631	0%	0	
2004	295,405	2,018,428	1,012	6,360	0%	0	

2005	274,002	2,292,430	1,161	7,296	0%	0	
2006	287,702	2,580,132	1,282	8,058	50%	641	4,029
2007	302,080	2,882,212	1,403	8,817	65%	912	5,731
2008	317,000	3,199,212	1,528	9,603	75%	1,146	7,202
2009	333,000	3,532,212	1,653	10,388	75%	1,240	7,791
2010	349,000	3,881,212	1,782	11,199	75%	1,336	8,399
2011	367,000	4,248,212	1,912	12,016	75%	1,434	9,012
2012	385,000	4,633,212	2,047	12,864	75%	1,535	9,648
2013	404,000	5,037,212	2,185	13,731	75%	1,638	10,299
2014	425,000	5,462,212	2,326	14,618	75%	1,745	10,963
2015	446,000	5,908,212	2,473	15,541	75%	1,855	11,656
2016	468,000	6,376,212	2,625	16,497	75%	1,969	12,372
2017	492,000	6,868,212	2,782	17,483	75%	2,087	13,113
2018	516,000	7,384,212	2,946	18,514	75%	2,209	13,885
2019	542,000	7,926,212	3,114	19,570	75%	2,336	14,677
2020	569,000	8,495,212	3,291	20,682	75%	2,468	15,512
2021	598,000	9,093,212	3,474	21,832	75%	2,606	16,374
2022	0	9,093,212	3,665	23,032	75%	2,749	17,274
2023	0	9,093,212	3,384	21,266	75%	2,538	15,950
2024	0	9,093,212	3,123	19,626	75%	2,342	14,719
2025	0	9,093,212	2,882	18,112	75%	2,162	13,584
2026	0	9,093,212	2,662	16,729	75%	1,996	12,548

Methane Content of LFG Adjusted to:	50%
Methane generation rate constant (k):	0.08 /yr
Ultimate methane generation potential (L_0):	84 m^3/tons waste

Step 2 estimation of the amount of methane destroyed by heat supply ($MD_{thermal.y}$)

The formula for estimation of the amount of methane consumed by heat supply as follows,

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

Where $LFG_{thermal,y}$ is measured in cubic meters. W_{CH4} is assumed to be 50% ex-for the ex-ante estimate according to spot tests done at the landfill. The value for W_{CH4} will be continuously monitored. D_{CH4} is assumed to be 0.0007168 tonsCH_4/m^3CH_4 taken from the IPCC default values for the fraction of methane in landfill gas. Therefore, the amount of methane consumed by the boilers in each project year is shown in the table below. The calculations in the tables below assume 8000 hours of operation for each of the boilers. There are 3 boilers installed in the first year, and the number of boilers increased to 4 and 5 in the years 2007 and 2009 respectively.

Table 7. Calculation of $MD_{thermal,y}$ by year

Year	LFG Generated per hour (m^3/hour)	Methane Generated per hour (m^3/hour)	$MD_{thermal}$ (tons/year) for the generation of thermal energy
*LFGthermal*Wch4*Dch4*			
2007	2,192	1,096	5,229
2008	2,192	1,096	6,285
2009	2,740	1,370	7,110
2010	2,740	1,370	7,661
2011	2,740	1,370	7,856
2012	2,740	1,370	7,856
2013	2,740	1,370	7,856

Step 3 Estimation of the amount of methane consumed by the flaring（$MD_{flared,y}$）

According to the feasibility study, the balance of the methane not used in the boilers will be flared. Therefore, the formula for estimation of the amount of methane consumed by the flaring is:

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

where:

Where $LFG_{flare,y}$ is measured in cubic meters. W_{CH4} is assumed to be 50% ex-for the ex-ante estimate according to spot tests done at the landfill. The value for W_{CH4} will be continuously monitored. D_{CH4} is assumed to be 0.0007168 taken from the IPCC default values for the fraction of methane in landfill gas. FE for this project is assumed to be 97% according to manufacture's specifications. The flare efficiency will be monitored ex-post as required by ACM0001's monitoring requirements.

The figure for $LFG_{flare,y}$ comes is the balance of the LFG subtracted from the collection system and not used in the boilers, and therefore is highly variable depending on the number of boilers installed each year and rate of gas extraction in that given year. The year-by-year ex-ante estimate of $LFG_{flare,y}$ is given in the table below.

Table 8 Calculation of MD_{flare} by year

Year	LFG Generated per hour (m^3/hour)	Methane Generated per hour (m^3/hour)	MD_{Flare} (tons/year) methane destroyed by flaring)
2007	-	-	3
2008	99	50	276
2009	-	-	-
2010	-	-	-
2011	128	64	356
2012	330	165	917
2013	536	268	1,492

Step 4 Estimation of the amount of the methane destroyed by the project（$MD_{project,y}$）

According to ACM0001 methane destroyed by the project is defined as the sum of results of step 2 and step 3 or:

$$MD_{project,y} = MD_{thermal,y} + MD_{flared,y}$$

Year by year calculations of $MD_{project,y}$ is given in the table below:

Table 9. Calculation of $MD_{project,y}$ by year

Year	MD_{Flare} (tons/year)	$MD_{thermal}$ (tons/year)	$MD_{project}$ (tons/year)	CO_2 equivalent (tons/year)
2007	3	5,229	5,232	109,872
2008	276	6,285	6,561	144,342
2009	-	7,110	7,110	163,530
2010	-	7,661	7,661	183,864
2011	356	7,856	8,212	205,300
2012	917	7,856	8,773	228,098
2013	1,492	7,856	9,348	252,396

Step 5 Estimation of the amount of methane destroyed according to the regulatory requirements in the absence of the project.（$MD_{reg,y}$）

The Jiaozishan landfill was built in 1992, there was no recycling systems requirements for landfill gas, according to the standard at the time. According to the *Criterion of Sanitary Technological landfilling for Household Waste* issued and implemented in 2004, all landfills are required to set up effective system of LFG recovery and destroy methane by flaring. However, this regulation is only suitable for new constructed landfills, but not applicable to those landfills that are already functioning. Moreover, considering the huge investment requirements for reconstruction, Chinese government may not issue compulsory regulations or laws that require present landfills to reconstruct. Therefore, both AF and $MD_{reg,y}$ are zero.

Step 6 Estimation of the electricity consumed by the project, EL_y

Since the Jiaozishan landfill gas project does not recover landfill gas for the production of electricity, the net quantity of electricity exported, EL_y, will be negative due to power consumption on site. The table below shows the power uses on site and the associated power consumption in order to calculate EL_y.

Table 10 Estimation of EL_y

Equipment	kW	hours	Load(%)	EL_y (MWh)	$CEF_{electricity,y}$ (tCO_2/MWh)	CO_2 equivalent (tons/year)
Air Compressor	15	8000	30%	36	0.866	31
LFG Dehydration	10	8000	100%	80	0.866	69
Route Fan	30	8000	15%	36	0.866	31
LFG boiler burner	11	8000	100%	88	0.866	76
Feed water pump	6	8000	100%	48	0.866	42
Water softener	1	8000	100%	8	0.866	7
Lighting	5	8000	30%	12	0.866	10
Water pump for heat exchanger	5.5	8000	70%	30.8	0.866	27
Total	**83.5**			**338.8**		**293**

Step 7 Estimation of the fossil fuel consumed by the project, ET_y

The Jiaozishan landfill gas project utilises diesel for transportation of hot water as decribed above. The diesel consumption is calculation as set out in the table below.

Table 11 Estimation of (ET_y * $CEF_{thermal,y}$)

HW_y (tonnes)	HW_{truck} (tonnes/truck)	$COEF_D$ (gCO2/km)	D_{trip} (km)	(ET_y * $CEF_{thermal,y}$) ($tonnesCO_2$/year)
333,333	8	1097	30	1371

Step 8: Estimation of emission reduction, ERy

The emission reductions are calculated as follows:

Table 1: Calculation of ER_y by year

Year	Total Mathane destroped by the project (tCO_2e/year)	$MD_{reg,y}$ (tons/year)	Project emission from power consumed (tCO_2e/year)	Project emission form fossil fuel consumed (tCO_2e/year)	ER (tCO_2e/year)
2007	109,872	0	293	1371	108,264

2008	144,342	0	293	1371	136,165
2009	163,530	0	293	1371	147,691
2010	183,864	0	293	1371	159,275
2011	205,300	0	293	1371	170,844
2012	228,098	0	293	1371	182,620
2013	252,396	0	293	1371	194,700
Total	**183,915**	**0**	**1,940**	**9597**	**1,099,559**

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

The values obtained when applying the formulae above for the first crediting period are as seen in the Table below:

Year	Estimation of project activity emission (tCO_2e)	Estimation of baseline emission(tCO2e)	Estimation of leakage (tCO2e)	Estimation of emissions reductions (tCO2e)
2007	1,664	109,872	0	108,264
2008	1,664	144,342	0	136,165
2009	1,664	163,530	0	147,691
2010	1,664	183,864	0	159,275
2011	1,664	205,300	0	170,844
2012	1,664	228,098	0	182,620
2013	1,664	252,396	0	194,700
Total	**11648**	**183,915**	**0**	**1,099,559**

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/year
Description:	Total Amount of landfill gas destroyed by boiler and flare.
Source of data to be used:	Measurements from flow meters
Value of data applied for the purpose of calculating expected emission reductions in section B.5	
Description of measurement methods and procedures to be applied:	Measured by a flow meter. Data to be aggregated monthly and yearly
QA/QC procedures to be applied:	Backup meters, electronic data archives
Any comment:	The detailed information please see Annex 4.

Data / Parameter:	$LFG_{thermal, y}$
Data unit:	m^3/year
Description:	Amount of landfill gas for boilers
Source of data to be used:	Measurements from flow meters
Value of data applied for the purpose of calculating expected emission reductions in section B.5	
Description of measurement methods and procedures to be applied:	Measured by a flow meter. Data to be aggregated monthly and yearly
QA/QC procedures to be applied:	Backup meters, electronic data archives
Any comment:	The detailed information please see Annex 4.

Data / Parameter:	$LFG_{flare,y}$
Data unit:	m^3/year
Description:	Amount of landfill gas flared
Source of data to be used:	Measurements from flow meters
Value of data applied for the purpose of calculating expected emission reductions in section B.5	
Description of measurement methods and procedures to be applied:	Measured by a flow meter. Data to be aggregated monthly and yearly
QA/QC procedures to be applied:	Backup meters, electronic data archives
Any comment:	The detailed information please see Annex 4.

Data / Parameter:	$W_{CH4,y}$
Data unit:	m^3 **CH_4** / m^3 **LFG**
Description:	Methane fraction in the landfill gas
Source of data to be used:	Measurements from continuous gas quality analyzer
Value of data applied for the purpose of calculating expected emission reductions in section B.5	
Description of measurement methods and procedures to be	Measured by a continuous gas quality analyzer. Data to be aggregated monthly and yearly

applied:	
QA/QC procedures to be applied:	Backup analyzers, electronic data archives
Any comment:	The detailed information please see Annex 4.

Data / Parameter:	**T**
Data unit:	Degrees Celsius
Description:	Temperature of the landfill gas
Source of data to be used:	
Value of data applied for the purpose of calculating expected emission reductions in section B.5	
Description of measurement methods and procedures to be applied:	Measured to determine the density of methane D_{CH4}. No separate monitoring of temperature is necessary when using flow meters that automatically measure temperature and pressure, expressing LFG volumes in normalized cubic meters.
QA/QC procedures to be applied:	Backup thermometers, electronic data archives
Any comment:	The detailed information please see Annex 4.

Data / Parameter:	**P**
Data unit:	Pa
Description:	Pressure of the landfill gas
Source of data to be used:	
Value of data applied for the purpose of calculating expected emission reductions in section B.5	
Description of measurement methods and procedures to be applied:	Measured to determine the density of methane D_{CH4}. No separate monitoring of pressure is necessary when using flow meters that automatically measure temperature and pressure, expressing LFG volumes in normalized cubic meters.
QA/QC procedures to be applied:	electronic data archives
Any comment:	The detailed information please see Annex 4.

Data / Parameter:	**FE**
Data unit:	%
Description:	Flare/combustion efficiency, determined by the operation hours (1) and the methane content in the exhaust gas (2)
Source of data to be used:	Measurements from flow meters
Value of data applied	

for the purpose of calculating expected emission reductions in section B.5	
Description of measurement methods and procedures to be applied:	The flare operation shall be continuously monitored by continuous measurement of operation time of flare using a run time meter connected to a flame detector or a flame continuous temperature controller, irrespective of whether the flare efficiency is monitored. Periodic measurement of methane content of flare exhaust gas. The enclosed flares shall be operated and maintained as per the specifications prescribed by the manufacturer.
QA/QC procedures to be applied:	Backup meters, electronic data archives
Any comment:	The detailed information please see Annex 4.

Data / Parameter:	**EL_{IMP}**
Data unit:	MWh/year
Description:	Total amount of electricity imported to meet project requirements
Source of data to be used:	Measurements from monitors
Value of data applied for the purpose of calculating expected emission reductions in section B.5	
Description of measurement methods and procedures to be applied:	Required to determine CO_2 emissions from use of electricity or other energy carriers to operate the project activity.
QA/QC procedures to be applied:	electronic data archives
Any comment:	The records of any electricity imported in the baseline too should be recorded at the start of project

Data / Parameter:	**HW_y**
Data unit:	tons/year
Description:	**HW_y** is the total amount of hot water produced in year, y, in tonnes and is monitored as a means to calculate **ET_y**, the total quantity of diesel consumed by the trucks in year y.
Source of data to be used:	**HW_y** will be calculated according to the number of trucks and the back up will be temperature and flow meters.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	333,333 tonnes

Description of measurement methods and procedures to be applied:	
QA/QC procedures to be applied:	
Any comment:	The detailed information please see Annex 4.

Data / Parameter:	
Data unit:	Hours
Description:	Operation of the boiler
Source of data to be used:	
Value of data applied for the purpose of calculating expected emission reductions in section B.5	8000
Description of measurement methods and procedures to be applied:	Measure the operational parameter in the boiler and the relative control system.
QA/QC procedures to be applied:	
Any comment:	This is monitored to ensure methane destruction is claimed for methane used in boiler plant when it is operational

B.7.2 Description of the monitoring plan:

The owner of the project is the operator of the project. The quality assurance practices that will be implemented by the operator will include the use of advanced automatic methane monitoring facility. The collected data will be aggregated and analyzed by a trained engineer on a monthly basis. The monitoring reports will be compiled into an annual report at the end of every year that will for the basis for the calculation of CERs and for verification. Mr. Zhou Feng will be in charge of monitoring works.

These include:

- Install monitoring equipment, such as flow meters, gas quality analyzers, and so on.
- Set up a central control system that links to all online monitoring equipment to collect and record all data relevant for monitoring the project activity. All data should be double checked before being archived.
- Designate qualified technical personnel to take charge of the monitoring work. All technical staff will receive appropriate training in order to operate the monitoring equipment.
- Deliver the monitoring and record data in accordance with monitoring plan. Mr. Zhou Feng will be responsible of double-checking the acquired data.
- All data, including electronic files, hardcopies of data and sale clips, will be kept in archives for transparency.

- Prepare regular monitoring reports for verification by the Designated Operational Entity and Carbon Credit Buyers, and take proper measures to ensure the quality of the reports according to the regulations of CDM and the requirements of ERPA.

The monitoring of emission reductions during the project activity, the operation plan and management framework will be designed in accordance with the guidelines reported in Annex 4: monitoring plan.

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)

The baseline and monitoring study was completed on the 10th February 2006

Name	
Madeleine Rawlins CAMCO International Suite 906, Lucky Tower A, No. 3 North Road, East 3rd Ring Road, Chaoyang District, Beijing 100027, China Tel: (86 10) 8448 3025/3049/1385/1623 Fax: (86 10) 8448 2499/2432 email: madeleine@camco-international.com.cn Website: www.camco-international.com	Mr. Li Jianping Nanjing Yunsheng New Energy Development Co. Ltd. Kechuang Center, Economic and Technolocy Development Zone, Jiangning District, Nanjing 211100 China Tel: +86 25 5218 5888 Fax: +86 25 52741176 E-mail: zhou_feng@126.com

Both Camco International Limited and Nanjing Yunsheng New Energy Development Co. Ltd. are the proposed project participants.

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:

>>
30/06/2006

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

>>
25 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:

>>
01/06/2007

C.2.1.2. Length of the first crediting period:

>>
7 years

C.2.2. Fixed crediting period:

C.2.2.1. Starting date:

>>
N/A

C.2.2.2. Length:

>>
N/A

SECTION D. Environmental impacts

>>

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

>>

The environmental impacts report of the proposed project had been finished by the Institute of Environmental Science Studies at Nanjing University, and was approved by the Jiangning District Environmental Protection Bureau of Nanjing City on 16th, Jul., 2005. Archived as follows：

Analysis of environmental impacts during construction period:

The main environmental impacts during construction period include noise, dust, constructive waste, human sewage, and human waste caused by the construction of the project. These impacts are all temporal and with the effective measures being taken, the negative impacts on environment will disappear after the complete of the project.

Analysis of environmental impacts during operation period.

1. **Analysis of impacts on atmospheric environment.**

During operation, the proposed project will supply heat through combusting the methane in the landfill gas, consequently reducing uncontrolled emission of landfill gas, alleviating the smell of the landfill, and reducing greenhouse gases emissions. All these are benefit for improving the quality of the atmosphere.

During operation, the heat supply boilers will adhere to the second category of the *Atmospheric contaminations Synthesized Emission Standards for Boiler (*GB12348-2001*)*. All exhaust gas contaminations will therefore be vented in accordance with the related standard and the exhaust emissions will adhere to regional environmental quality standards.

2. **Analysis of impacts on water environment**

The waste water produced during operation of the project comes from both the condensation of landfill gas and waste water from staff facilities. The condensation water produced by the project activity will be filled into the sewage treatment plant in the landfill through water pump. The human sewage will enter a separate sewage treatment system. The emission of treated sewage will not bring any negative impact on the water environment nearby.

3. **Analysis of acoustic environment**

The noise emissions of the project during operation mainly comes from pre-treatment of landfill gas (pressurisation fan), discharging of condensation water (water pump), heat supply by landfill gas (heat supply boilers), and flaring of landfill gas (burner). No residents live within 1.5 km around the plant boundary. Therefore, the noise during operation will adhere to environmental standards and has very little impact on the regional acoustic environment.

4. **Analysis of impacts on environment by solid waste**

The solid waste produced by the project mainly comes from the scale and deposed lubricating oil during maintenance of equipment. Given that the industrial waste constitutes only a very amount, the waste will be collected on site and sent to the industrial waste treatment factory when there is sufficient to be transported. This will ensure that the waste will not pollute the environment.

5. Analysis of impacts on the biological environment

The construction of the project had started in No.3 storage area of Jiaozishan landfill that had been closed, and green vegetation work will be delivered in the plant of landfill gas heat supply plant, which will form integrated plant community and enhance the biological environment of the site.

In summary the project employs advanced gas heat supply technology with high level of automation. The project has little impact on the surrounding environment and does not have any trans-boundary impacts.

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:

>>

The implementation of the proposed project will not bring about significant impacts on the environment and the protecting measures taken by the project are reasonable and effective. Implementation of the proposed program takes full advantage of the landfill gas captured in the Jiaozishan landfill and reduces the emission of greenhouse gases.

SECTION E. Stakeholders' comments

>>

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

>>

The proposed project gained approval from the Development and Reform Committee of Nanjing City. In order to collect local stakeholders' opinions and views on the project, on 20th, Dec. 2005, the developer invited the stakeholders to the Jiaozishan landfill to express their view of the project. Participants included related personnel from Nanjing City's Appearance Administration Bureau, Administrative Office of Landfills of Nanjing City, Jiaozishan Landfill, Dou Village, and the Administrative Committee of Development Zone of Jiangning District.

E.2. Summary of the comments received:

>>

Both Nanjing City's Appearance Administration Bureau and the Administrative Committee of Development Zone of Jiangning District approve of and actively promote the construction of the project.

Villagers from Dou village think that the construction of the project will reduce the odour of the landfill and enhance the quality of life for villagers nearby. Moreover, the project will not take over any new land or bring about any additional pollution, which means the project will not bring any negative impact to the community. The villagers are in favour of the project.

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

>>

N/A. No negative comments were received.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

Organization:	The Administrative Office of landfills of Nanjing City
Street/P.O.Box:	
Building:	
City:	Nan Jing
State/Region:	Jiang Su
Postfix/ZIP:	
Country:	PRC
Telephone:	+86-25-5274-1184
FAX:	+86-25-5274-1176
E-Mail:	
URL:	
Represented by:	Chen, Mingdong
Title:	Chief Officer
Salutation:	Mr
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Middle Name:	--
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Department:	--
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Represented by:	
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Last Name:	Graham
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Department:	
Mobile:	
Direct FAX:	As Above

Direct tel:	As Above
Personal E-Mail:	James.graham@camco-international.com

Annex 2

INFORMATION REGARDING PUBLIC FUNDING

Annex 3

BASELINE INFORMATION

Calculation for L_0 and estimating k

L_0——Methane Generation Potential (m3/tons waste)
According to “Revised 1996 Guidelines for National Greenhouse Gas Inventories: Refernce Manual”and “Uncertainty Management in National Greenhouse Gas Inventories”, it defines as follows:

$Lo=MCF* DOC* DOC_f* F* 16/12$

where:

- MCF = methane correction factor (fraction) fraction of MSW disposed to solid waste disposal sites. Jiaozishan landfill belongs to the managed SWDS defined in IPCC. So the value is 1.0.
- DOC = degradable organic carbon (fraction), which need to be calculated by formula below.
- DOC_F = fraction DOC dissimilated. According to “Uncertainty Management in National Greenhouse Gas Inventories”, the default value could be 0.5-0.6, considering the situation of Jiaozishan landfill. Here takes 0.55.
- F = fraction of CH4 in landfill gas (default is 0.5)

DOC= 0.4 (A) + 0.17 (B) + 0.15 (C) + 0.30 (D)
where:

- A = per cent MSW that is paper and textiles
- B = per cent MSW that is garden waste, park waste or other non-food
- organic putrescibles
- C = per cent MSW that is food waste
- D = per cent MSW that is wood or straw

According to “MSW disposal plan before 2010 in Nanjing Center District”, the estimation of waste content in Nanjing city is as follows:

The Fraction of Waste in Nanjing city	
A. Paper and textiles	Testing value 20.5%
B. Garden and park waste and other (non-food) putrescibles	Testing value 0%
C. Food waste	Testing value 48%
D. Wood and straw waste	Testing value 3.4%
Plastic、rubber and so on	Testing value 28.1%

The calculation results based on the data above, the value of DOC is 0.164(Gg C/Gg waste), or 84 m^3 CH_4/tons waste.

K——methane generation rate constant (1/yr)
According to "Revised 1996 Guidelines for National Greenhouse Gas Inventories: Refernce Manual"and "Uncertainty Management in National Greenhouse Gas Inventories", it defines as follows:

K= In 2/ $t_{1/2}$

This value is based on the environment in which the SWDS is located. Higher k values are associated with greater moisture in the SWDSs and other factor such as content of waste, humidity, anaerobic condition. Values for k may range from less than 0.005 per year to 0.4 per year (LANDTEC, 1994; US EPA 1991).The experts indicate that $t_{1/2}$ will be 18 years in Jiaozishan landfill. And then the value of k would be 0.077/year. Considering that the area of the Nanjing Landfill site is around 1000 mm/yr, and the humility is such high, based on the adjust factor from EPA Model. It is estimated that k would be 0.08/year.

Table 2 Application of FOD Model

Year, x	Tonnes of waste disposed per year, R_x	k	L_o (m^3/tonne)	$\Sigma Q_{T,x}$ (m^3 CH_4 / year)	Collection Efficiency η(%)	Total methane collected (m^3)	Total methane collected (tonnes)
1995	147,581	-	-	-	-	-	0
1996	157,002	0.080	84	991,338	0%	-	710
1997	167,023	0.080	84	1,969,742	0%	-	1,414
1998	177,684	0.080	84	2,940,236	0%	-	2,112
1999	189,025	0.080	84	3,907,727	0%	-	2,803
2000	201,091	0.080	84	4,877,015	0%	-	3,500
2001	213,927	0.080	84	5,852,830	0%	-	4,198
2002	227,582	0.080	84	6,839,844	0%	-	4,908
2003	242,108	0.080	84	7,842,697	0%	-	5,631
2004	295,405	0.080	84	8,866,021	0%	-	6,360
2005	274,002	0.080	84	10,168,678	0%	-	7,296
2006	287,702	0.080	84	11,227,412	50%	5,613,706	8,058
2007	302,080	0.080	84	12,296,774	65%	7,992,903	8,817
2008	317,000	0.080	84	13,380,499	75%	10,035,374	9,603
2009	333,000	0.080	84	14,481,125	75%	10,860,844	10,388
2010	349,000	0.080	84	15,604,607	75%	11,703,455	11,199
2011	367,000	0.080	84	16,749,188	75%	12,561,891	12,016
2012	385,000	0.080	84	17,926,679	75%	13,445,009	12,864
2013	404,000	0.080	84	19,134,551	75%	14,350,913	13,731
2014	425,000	0.080	84	20,377,185	75%	15,282,889	14,618
2015	446,000	0.080	84	21,665,343	75%	16,249,008	15,541
2016	468,000	0.080	84	22,995,526	75%	17,246,644	16,497

2017	492,000	0.080	84	24,371,218	75%	18,278,413	17,483
2018	516,000	0.080	84	25,802,356	75%	19,351,767	18,514
2019	542,000	0.080	84	27,284,677	75%	20,463,507	19,570
2020	569,000	0.080	84	28,827,680	75%	21,620,760	20,682
2021	598,000	0.080	84	30,433,417	75%	22,825,062	21,832
2022	0	0.080	84	32,110,499	75%	24,082,874	23,032
2023	0	0.080	84				21,266
2024	0	0.080	84				19,626
2025	0	0.080	84				18,112
2026	0	0.080	84				16,729
2027	0	0.080	84				
2028	0	0.080	84				

Annex 4

MONITORING INFORMATION

1.0 INTRODUCTION

This annex outlines the procedures that Nanjing Yunsheng New Energy Development Co. Ltd. proposes to follow to ensure that the operation of the project complies with the CDM requirements and monitoring and verification plan outlined in the Project Design Document.

The owner of the project is the operator of the project. The quality assurance practices that will be implemented by the operator will include the use of advanced automatic methane monitoring facility. The collected data will be aggregated and analyzed by a trained engineer on a monthly basis. The monitoring reports will be compiled into an annual report at the end of every year that will for the basis for the calculation of CERs and for verification. Mr. Zhou Feng will be in charge of monitoring works.

These include:

- Install monitoring equipment, such as flow meters, gas quality analyzers, and so on.
- Set up a central control system that links to all online monitoring equipment to collect and record all data relevant for monitoring the project activity. All data should be double checked before being archived.
- Designate qualified technical personnel to take charge of the monitoring work. All technical staff will receive appropriate training in order to operate the monitoring equipment.
- Deliver the monitoring and record data in accordance with monitoring plan. Mr. Zhou Feng will be responsible of double-checking the acquired data.
- All data, including electronic files, hardcopies of data and sale clips, will be kept in archives for transparency.
- Prepare regular monitoring reports for verification by the Designated Operational Entity and Carbon Credit Buyers, and take proper measures to ensure the quality of the reports according to the regulations of CDM and the requirements of ERPA.

2.0 DATA TO BE MONITORED AND RECORDED (AS PER THE PDD)

There are three sets of variables that require monitoring in the Jiaozishan Landfill Gas Recovery and Utilisation Project. These are methane destruction, electricity utilisation on site and diesel consumption by the hot water delivery trucks. Baseline emissions will be based upon methane destroyed by the boilers, and if installed in future, the flare. Project emissions will be based upon the diesel and power consumption. The emission reductions are the difference between the two. The figure below shows the boundary of the project and the process that is to be monitored.

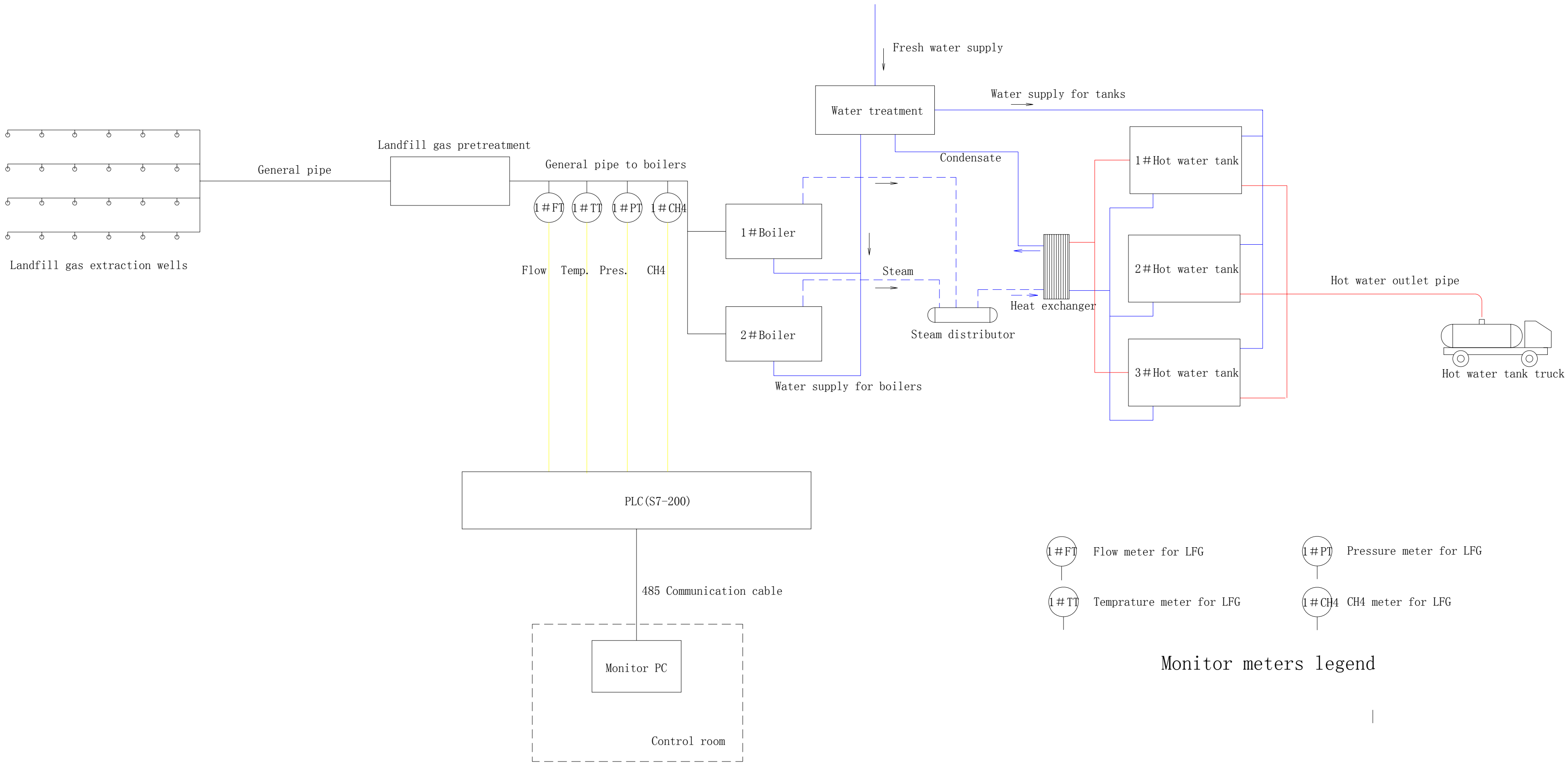

Figure 5. The Jiaozishan Landfill Gas Recovery and Utilisation Process

According to the methodology the table below shows the parameters to be monitored and a the monitoring equipment and procedures to be implemented

Data Number	Data Unit	Instrumentation	Accuracy	Range	Calibration	Procedure	Back Up
D2.2.1-1.	**$LFG_{total,y}$**	Orface	1%	150-1500Nm3/h	Once a year by meter manufacturer	Reported daily in an Excel spreadsheet	A portable LFG meter (CH4, O2, CO2, flow, temperature and pressure) is available for backup and for use during calibration. Data from the meter will be dowloaded to Excel
D2.2.1-2	**$LFG_{flare,y}$,**	N/A as there is currently no flare	N/A	N/A	N/A	N/A	
D2.2.1-3	**$LFG_{thermal,y}$**	N/A. $LFG_{thermal,y} = LFG_{total,y}$	N/A	N/A	N/A	N/A	
D2.2.1-4	**FE**	N/A as there is currently no flare	N/A	N/A	N/A	N/A	
D2.2.1-5.	**$W_{CH4,y}$**	Infrared methane meter	2%	0-100%	Twice a year by Nanjing University	Sampled and stored in Excel	N/A
D2.2.1-6	**T**	Pt100	0.5^{o}C	-20^{o}C to +80^{o}C	Once a year by meter manufacturer	Reported daily in an Excel spreadsheet	A portable LFG meter (CH4, O2, CO2, flow, temperature and pressure) is available for backup and for use during calibration. Data from the meter will be dowloaded to Excel
D2.2.1-7	**P**	Diffuse Silicon Membrane	1%	0 to 40kPa	Once a year by meter manufacturer	Reported daily in an Excel spreadsheet	A portable LFG meter (CH4, O2, CO2, flow, temperature and pressure) is available for backup and for use during calibration. Data from the meter will be dowloaded to Excel
D2.2.1.-8	**EL_{IMP}**	Electricity Meter	1%	0-200kw	Calibrated by local	Daily power consumption is	Invoices will be used as back up for power consumption.

					government	recorded on paper and in Excel	
D2.2.1.-9	**HW_y**	This is needed to approximate diesel consumption. A maximum value is taken for conservatism and the number of trucks is monitored. Maually metered according to number of trucks	N/A	N/A	N/A	Reported daily in an Excel spreadsheet	Should the records of the truck journeys be lost then the volume of hot water will be used to calculate the number of journeys and consequent diesel consumption.
D2.2.1.-10	**Hours**	Recorded manually daily	N/A	N/A	N/A	Reported daily in an Excel spreadsheet	

All relevant regulations for landfill gas projects will be monitored. The adjustment factor (AF) will be updated according to any relevant changes.

3.0 RECORD KEEPING, ERROR HANDLING AND REPORTING PROCEDURES

3.1 Record Keeping and Internal Reporting Procedure

Nanjing Yunsheng Engergy Development Company Limited has set up the measurement department whose director is Xu Ying. This department shall record the data parameters identified above on a daily basis into Excel. This data will be backed up weekly. Monitored data will be passed to the CDM responsible person on a monthly basis so that he/she can check the performance of the project activity against the PDD and also the delivery schedule of the Emissions Reductions Purchase Agreement.

A monitoring report will be completed by the CDM responsible person monthly in a format similar to that suggested below.

Bi-annually (or whenever verifications take place) the CDM Responsible Person will create a monitoring report for verification of the project. The Report should have appended to it the calibration certification of the meters and the report on daily and/or monthly data from the Project Company, and the same or similar as given in the example below.

All records should be kept in accordance with company guidelines and the applicable industrial codes and regulations. The records should be kept electronically and on paper for the length of the crediting period of the Project plus 3 years. Paper copies shall be filed in the same location as this CDM Procedures Manual.

3.2 Error Handling Procedure

In the event that a meter has lost calibration over the allowable error limit then this shall be corrected at the earliest opportunity and re-calibrated and the data recorded from this meter since the last successful calibration shall be ignored.

In the event that a there is uncertainty over the accuracy of the data set from the main meter (e.g. the meter has lost calibration over the acceptable error limit) then the data from the second meter or back up system shall be used. In the event that a there is uncertainty over the accuracy of the data set from the

The check of the CDM Project Officer and then the third party verifier prior to issuance of the CERs is considered adequate for errors in the calculations. Where errors in the calculations are discovered by either of these Parties, the monitoring report shall be modified and the corrected version shall be resubmitted to the verifier.

3.3. External Reporting Procedure

After signing by the CDM Project Officer, the report is sent to the Project Manager for signing prior to issuance to the 3rd party verifier which is contracted to verify the emissions reductions during the crediting period of the project.

3.4 Procedure for corrective actions arising

The CDM Project Officer is responsible for identifying corrective actions arising to the above procedures and for liaising with the purchaser, the 3rd party verifiers and other stakeholders to take necessary steps to implement the corrective actions.

Standard Template for Reporting of Data for Verification of CERs

Name of Project: The Jiaozishan Landfill Gas Recovery and Utilisation Project

Crediting Period for which ERs are claimed:

From [---Insert Date---] to [---Insert Date---]

Author of this Report: [Insert Name]

Date of Issuance of this Report to Verifier: [---Insert Date---]

Name and contact Details of Verifier: [Insert]

Number of ER's claimed during period: [Insert Number] t CO_2e

Equation from ACM0001: $ER_y = (MD_{project,y} – MD_{reg,y}) * GWP_{CH4} + EL_y * CEF_{electricity} - ET_y * CEF_{thermal,y}$

Global Warming Potential of Methane (GWP_{CH4}): 21

Baseline Grid Emissions Factor ($CEF_{electricity}$): 0.866 t CO_2e per MWh

Calculation and Data:

Month	Generation Period Start Date/End Date	$MD_{project,y}$	$MD_{reg,y}$	GWP_{CH4}	EL_y	$CEF_{electricity}$ (tCO2e/MWh)	(ET_y * $CEF_{thermal,y}$) (tonnesCO_2/year)	CERs Claimed
e.g. January 2007	01/01/2007 – 31/01/2007			21		0.866		
				21		0.866		
				21		0.866		

This template shall not be altered. It shall be completed without modifying/adding headings or logo, format or font.

				21		0.866		
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				21		0.866		
				21		0.866		
				21		0.866		
				21		0.866		
Total				21		0.866		

Comments:

Signed: ___________________________ (CDM Officer) Date:___________

Signed: ___________________________ (Board Representative) Date:___________

Attachments Checklist:
Monthly Landfill Gas Utilisation and Quality Reports
Monthly Power Consumption Reports
Monthly Boiler Operation Reports
Monthly Hot Water and Logistics Report
Calibration certification of the meters
Power Sales Invoices/Receipts (if required)