**CLEAN DEVELOPMENT MECHANISM**
**PROJECT DESIGN DOCUMENT FORM (CDM-PDD)**
**Version 02 – (in effect as of: 1 July 2004)** [1]

**CONTENTS**



[1] The PDD form is revised according to EB 19 Report Annex 14: REVISED GUIDELINES FOR COMPLETING THE FORMS: CDM-PDD, CDM-NMB AND CDM-NMM, 13 May, 2005.

## SECTION A. General description of project activity

### A.1 Title of the project activity:

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Shenzhen Xiaping Landfill Gas Collection and Utilization Project
Version number of the document: 2
Date: Oct, 15th 2005.

### A.2. Description of the project activity:

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The Shenzhen Xiaping Landfill Gas Collection and Utilization Project (hereafter referred to as the Proposed Project) developed by Shenzhen Lisai Development Co., Ltd (hereafter referred to as the Project Owner) is a landfill gas (LFG) collection and utilization project in the Xiaping Landfill of the Luohu District, Shenzhen City, Guangdong Province, P.R.China. The project will have an LFG upgrade system with 500m3/h processing capacity. The proposed project will invest in construction of a LFG collection system covered the Xiaping Landfill, and utilize the collected LFG to produce Compressed Purified Landfill Gas (CPLG) and to generate power. Excess LFG, all gas collected during the period when LFG upgrade system is not operated will be flared.

Xiaping Landfill is the largest operated sanitary landfill in Shenzhen City at present. It was put into operation in Oct, 1997 with 25 years of designed operation period. It receives an average of 3,000t of domestic waste per day mainly from Luohu District and Futian District. With more than 6Mt domestic waste been filled, the maximal landfill depth is about 60m and the estimated LFG generation rate is about 300,000~500,000$m^3$ per day at present and will be increased in the future with more domestic waste to be filled.

The main components of LFG are methane (CH4, 50% content rate) and carbon dioxide (CO2), which is one of six categories of greenhouse gases (GHGs) that has high Global Warming Potential (GWP). Since there is no mandatory requirement on LFG collection, utilization or flaring in China, the LFG arising from the most landfills includes the Xiaping Landfill is uncontrolled release into the atmosphere currently. The uncontrolled release of methane will have negative effects on global climate.

The objective of the Proposed Project is to collect and utilize the LFG of the Xiaping Landfill. The Project Owner has signed cooperation agreement with the Shenzhen Xiaping Landfill in May, 2005. According to the cooperation agreement, the Project Owner should pay for collection and utilization of each cubic meter of LFG to Shenzhen Xiaping Landfill, while the Project Owner owns all benefit being generated from collection and utilization of LFG. The Proposed Project involves of investing and operating three main activities:

(1) Construction and operation of LFG collection system. The LFG arising from the solid wastes is concentrated in the vertical shaft and extracted to the ground by Root's blower.

There is no shaft in the Xiaping Landfill prior to the Proposed Project. All vertical shafts are new build during implementation of the Proposed Project.

(2) Construction and operation of LFG upgrades to CPLG system and LFG power plant. Limited by investment, the LFG utilization system will be constructed stage by stage. The first stage with 500$m^3$/h capacity will put into operation in early 2006. Through implementing of this system, about 500$m^3$/h of LFG will be upgraded to automobile fuel through compression, filtration，desiccation and pressure swing adsorption. LFG upgrade to CPLG system is stage by stage. The output of the LFG upgrade system is used as CPLG in the vehicles to substitute gasoline for transporting solid wastes to the Xiaping Landfill. With the CDM revenue of the Proposed Project to compensate investment and operation cost of subsequent system, the Project Owner will extend LFG utilization through construction of the second stage of LFG upgrade to CPLG system (1000 $m^3$/h, at the end of 2006) and the LFG power plant (total installed capacity 8MW, from 2007 to 2013).

(3) Construction and operation of a flaring system, excess LFG, all gas collected during the period when LFG upgrade system is not operated will be flared.

The implementing of the Proposed Project will convert the extracted LFG to CO2 and then released to the atmosphere. It will achieve the greenhouse gas (GHG) emission reductions by avoiding direct methane venting from the business-as-usual scenario. The emission reductions generated through substitution of gasoline by CPLG is not claimed in this PDD. The cumulative estimated GHGs emission reduction of the Proposed Project is 5,741,878 tCO2e, from 2006 to 2015. Technologies to be adopted by the Proposed Project are commonly used in the PRC and have been approved as reliable with years of experience.

The Project Owner is a specialized company that has participate in design and construction of several solid waste/dangerous waste landfills (pleases see Section A.3 for detail). The technology to be applied in the LFG collection system and flaring system is mature in China. Though the technology of LFG upgrade to CPLG is for the first time to be commercially applied in China, similar technology has been mature and popularized in textile and chemical industry. Based on years of study and test carried out by the Department of Environmental Science and Engineering of Tsinghua University, LFG upgrade to CPLG technology has been approved by the Ministry of Construction. The Department of Environmental Science and Engineering of Tsinghua University will provide technology support to the Proposed Project, therefore to promote utilization of LFG upgrade to CPLG technology and increase LFG collection and utilization in China.

The Proposed Project clearly fits into the sustainable development priority of the PRC, and its successful implementation will

(1) Greatly reduce environmental health risks, avoid bad odor and the potential for explosions in the local surroundings thus to optimize the use of natural resources by avoid uncontrolled release of LFG.

(2) Demonstrate clean technology with economic benefits and promote better management of

operated landfills throughout China, which could be replicated across the region.
(3) Promote capacity building and technology transfer of clean technologies, conserves natural resources and increase employment opportunities in the area where the Proposed Project is sited.
(4) Promote use of upgraded LFG as automobile fuel thus reduce natural gas consumption and promote the implementation of the "Clean Vehicle Action" in Shenzhen city to some extent.

## A.3. Project participants:

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Project Participants to the Proposed Project activity are as following:

**Table 1. Information of 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) |
|---|---|---|
| P. R. of China (host ) | | No |
| | Shenzhen Lisai Development Co. Ltd (project owner) | Yes |

*(*) In accordance with the CDM modalities and procedures, at the time of making the CDM-PDD public at the stage of validation, a Party involved may or may not have provided its approval. At the time of requesting registration, the approval by the Party(ies) involved is required.*

The following are the main Project Participants:

**Project Owner:** Shenzhen Lisai Development Co., Ltd. is the owner of the Proposed Project which conducts design, investment, construction, operation and management of the Proposed Project activities.

Shenzhen Lisai Development Co., Ltd is a private environmental protection company established in 2000. The company draws rich experience in advanced environmental technology research, design, production, installation, shakedown test, operation and consultation. Main business areas of the company include water supply, industrial and municipal waste water disposal, solid waste disposal or incineration, catering oil smoke control and etc.

Specializing in waste water disposal, and environmental protection facility operation, the company has acquired a license for the operation of environmental protection facilities, a license issued by the local government for the implementation of waste water, waste gas, noise-control engineering, and even won a award of national excellent in year 2004 (totally 18 excellent companies in China). The company also has the ISO 9001:2000 Qualification Certification.

The company has participated in the design and construction working processes for 10 environmental protection facilities, including the Shenzhen Hongmei Hazardous Landfill, Hunan Hengyang Medical Waste Landfill and the Hunan Yongzhou Medical Waste Landfill.

The company has established a long-term cooperative relationship with China Academic of Science, China Research Academy of Environmental Science, Tsinghua University and Shanghai Jiaotong University, etc.

**Host Country:** The host country is the People's Republic of China and the Designated National Authority is the National Development and Reform Commission of the Government of China. The Government of the People's Republic of China ratified Kyoto Protocol in September 2002.

**Purchasing Party:** The Project Owner has signed Exclusive Agreement with the Climate Change Capital Carbon Fund.

Detailed contact information of the Participants and other Parties are included 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):

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The Host Country is the People's Republic of China.

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

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Guangdong Province

#### A.4.1.3. City/Town/Community etc:

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Luohu District of the Shenzhen 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 sited within the Xiaping Landfill in the Qingshuihe River area in Luohu District, Shenzhen City of Guangdong province in south China. The geographical coordinates of the Xiaping Landfill is east longitude 113°34′ and north latitude 22°29′. It is in a northwest to southeast valley, 2km west to the Buji town, 2km north to the Shenzhen Institute of Physical Education and 1km northeast to the Yinhu Tourist Centre. It can be reached by car through Baojie Road which has been constructed specially for the transportation of the Xiaping Landfill and is connected to the Honggang road and Shenping arterial roads directly.

Figure 1 is a map showing the physical location of the Proposed Project site.

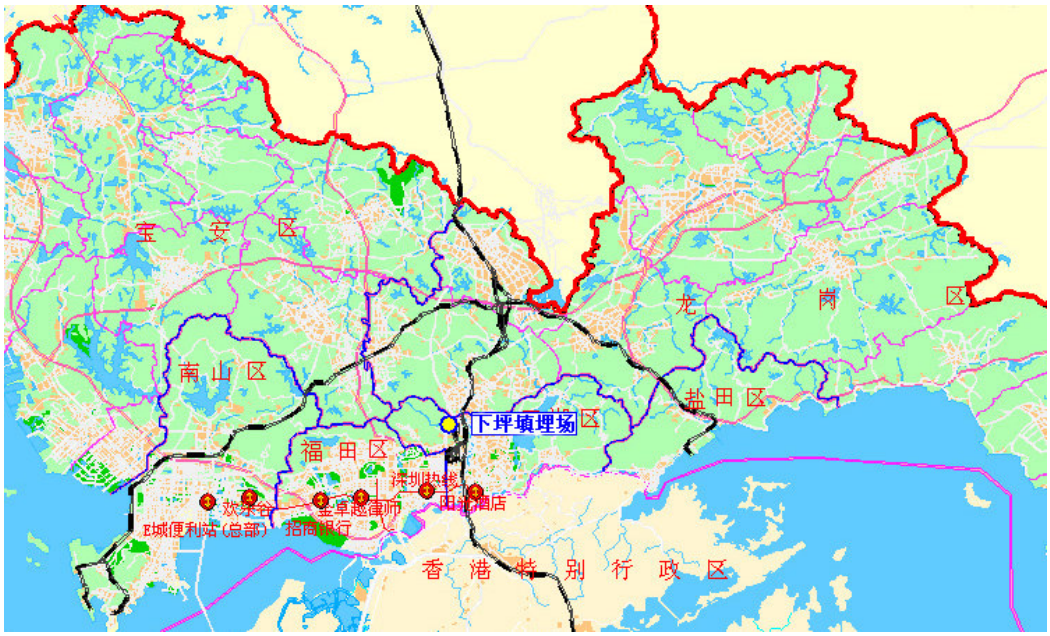


**Figure 1. Map of the Shenzhen City, and the location of the Proposed Project site**

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

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The Proposed Project would fall within sectoral scope 13: Waste handling and disposal.

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

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The Proposed Project includes three parts as LFG collection system, LFG utilization system (LFG upgrade to CPLG and LFG power plant) and LFG flaring system.

**LFG Collection System:**

Vertical shaft was used to collect the LFG upwards. Compare to horizontal shaft collection method, vertical shaft collection method is widely used in landfills for its characteristics in simple structure, high efficiency, low investment and better seal performance. Multi-hole pipes are installed perpendicularly in the vertical shaft filled with size-grade distribution of gravel stones to increase the adsorption area. Distance between vertical shafts is about 30~50m. Vertical shafts is fitted with collection pipe, valve and sampling pipe. LFG collected by the vertical shafts is concentrated in the collecting main and then extracted with Root's blower.

LFG collection system will contain all the necessary equipment for collection, metering, measuring and adjusting of LFG. Vertical shafts are isolated from each other for better gas collection. The valve on each shaft is adjusted about twice per week to maintain proper gas flow from each section of waste. The adjustment will be made based on the results of oxygen concentration in the gas determined using a portable oxygen analyzer.

LFG collection system will be fitted with manual and automatic control and check valves, a flame arrestor, gas sampling ports, pressure and temperature indicators, filters, flow meters, a PLC control system and continuous gas analyzers tat conform to the monitoring plan.

**LFG utilization system (system of upgrading LFG to CPLG and LFG power plant):**

CPLG is used as automobile fuel for several years in developed countries. Figure 2 shows the technology process of the system upgrading LFG to CPLG. This system is composed of pretreatment unit and production unit. LFG is compressed, condensate, multi-step filtrated and dried with $Al_2O_3$ to remove particles, water, $H_2S$ and other foreign substance. Then, it is flow into the production unit with stable flow rate and pressure. Methane and $CO_2$ in the LFG were separated by pressure swing adsorption (PSA) process in production unit. More than 92% of methane in LFG is absorbed in this system②. After shifting gasoline automobile to bi-fuel automobile and constructing specific gas fueling station, CPLG can be used in waste transportation to substitute certain amount of gasoline.

② Guaranteed by equipment supplier according to Purchase Agreement, detailed is available as DOE required.

Internal-combustion engine is applied in the LFG power plant. The installed capacity of LFG power plant will increase while considering the financial status. According to plan, the total installed capacity of 8MW is to be achieved in 2013. The Project Owner is supposed to supply electricity to Shenzhen Grid.

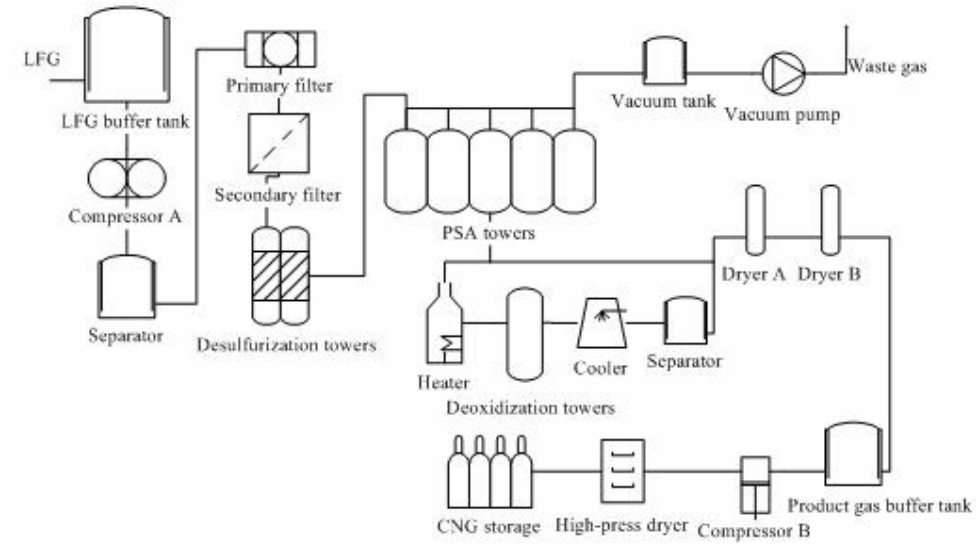


**Figure 2. Technology process of the system upgrading LFG to CPLG**

**LFG flaring system:**

LFG flaring system is directly connected to the LFG collection system and the system upgrading LFG to CPLG. It is used to combust the excessive LFG. LFG flaring system is composed of tower and flare equipment with continues igniter. Flaring capacity of each combustion heads of the LFG flaring system is 30-2640 Nm3/h. Its combustion efficiency is higher than 99%③.

**A.4.4. Brief explanation of how the anthropogenic emissions of anthropogenic greenhouse gas (GHGs) by sources are to be reduced by the proposed CDM project activity, including why the emission reductions would not occur in the absence of the Proposed Project activity, taking into account national and/or sectoral policies and circumstances:**

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The Proposed Project is based on three complementary activities, as follows:

- The collection and flaring of landfill gas, thus converting its methane content into $CO_2$, reducing its greenhouse effect; and
- The upgrade and supply of CPLG as automobile fuel to the transportation vehicles of the Xiaping Landfill, thus converting its methane content into $CO_2$, reducing its

③ Guaranteed by equipment supplier according to Purchase Agreement, detailed is available as DOE required.

greenhouse effect and not claim emission reduction for displacing CPLG from other sources.

- The LFG power generation to supply electricity to Shenzhen Grid, thus converting its methane content into $CO_2$ in internal-combustion engine, reducing its greenhouse effect and claim emission reduction for the displaced grid electricity.

The baseline scenario is defined as the most likely future scenario in the absence of the proposed CDM project activity. Establishing the future scenario requires an analysis and comparison of possible future scenarios using a comparison methodology that is justified for the project circumstances. Based on this analysis (See section B below), the baseline scenario is the continued uncontrolled release of LFG to the atmosphere, similarly to most landfills in China. At present, there are no national or local regulations regarding the collection of LFG from landfills, few landfills with LFG collection and utilization system were set up to develop experience with the technology with government support or international assistance. None of these projects were financially attractive, so the activity did not happen in China.

Although the government encourages landfills to sanitarily treat municipal waste, however, due to technical and economic barriers, the Chinese legislation does not require landfill operators to flare or recover LFG and the only requirement is passively to vent the LFG in order to avoid the risk of explosion.

The Proposed Project requires high initial investment and maintenance cost. The Proposed Project has significant environmental benefit, however, based on the financial analysis (See section B3 below), the Proposed Project IRR is negative without carbon revenue; while IRR is significantly improved with carbon revenue of CDM that leading to attractive and feasible. Clearly, the Proposed Project is not the economically most attractive course of action and therefore is not part of the baseline scenario. It can be concluded that emission reductions resulted from the Proposed Project are additional to any that would occur in absence of the Proposed Project. Therefore, the Proposed Project fulfils the additionality rule of CDM.

**A.4.4.1. Estimated amount of emission reductions over the chosen crediting period:**

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The Proposed Project is expected to avoid 5,741,878 tCO2e of emissions over the chosen crediting period (2006-2015).

Since the emission reductions are yearly different, please refer to table below for details on the quantification of GHG emission reduction associated with the Proposed Project.

| Year | Emission Reductions ($t-CO_2e$) |
|---|---|
| 2006 | 351,653 |
| 2007 | 397,961 |
| 2008 | 445,803 |
| 2009 | 495,534 |
| 2010 | 547,588 |
| 2011 | 598,836 |
| 2012 | 649,629 |
| 2013 | 700,393 |

| | |
|---|---|
| 2014 | 751,440 |
| 2015 | 803,041 |
| Total ($t-CO_2e$) | **5,741,878** |

**A.4.5. Public funding of the project activity:**

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No public funding from Annex I countries is involved in the Proposed Project.

## SECTION B. Application of a baseline methodology

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

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ACM0001--"Consolidated baseline methodology for landfill gas project activities". This consolidated baseline methodology is based on elements from AM0002, AM0003, AM0010, AM0011. For more information regarding the methodology please refer to http://cdm.unfccc.int/methodologies/approved.

### B.1.1. Justification of the choice of the methodology and why it is applicable to the project activity:

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The methodology ACM0001 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 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.

As previously described, the Proposed Project is based on three complementary activities, as follows:

- The collection and flaring of landfill gas, thus converting its methane content into $CO_2$, reducing its greenhouse effect; and
- The upgrade and supply of CPLG as automobile fuel to the transportation vehicles of the Xiaping Landfill, thus converting its methane content into $CO_2$, reducing its greenhouse effect and not claim emission reduction for displacing CPLG from other sources.
- The LFG power generation to supply electricity to Shenzhen Grid and claim emission reduction for displacing grid electricity, in converting its methane content into $CO_2$ in internal-combustion engine, reducing its greenhouse effect.

The project therefore fulfils the conditions of Option a), b) and c) (i.e. the captured land fill gas is directly flared or used to produce energy and part of the credits from displacing grid electricity is claimed) so that ACM0001 baseline methodology is considered the most appropriate methodology for the Proposed Project.

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.

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 a flaring system and a production system (to produce electricity, thermal energy or LFG upgraded CPLG).

The scenario that most likely occurs among the three alternative scenarios is analyzed as follows:

For Alternative 1, the landfill operator is not required to take any action and the cost is zero. Refer to the *National Action Plan for Collection and Utilization of Landfill Gas (12/2001)* , the *Technical Code for Sanitary Landfill of Municipal Domestic Refuse (CJJ17-2001)*, and the *Standard for Pollution Control on the Landfill Site for Domestic Waste (GB16889-1997*） , the Chinese legislation does not require landfill operators to flare or collect LFG. The only requirement is to passively vent the LFG in order to avoid the risk of explosion. Moreover, most landfills are far from residential areas and farms, the uncontrolled release of lower concentrated methane will not give rise to public concern on health. Therefore, Alternative 1 is a plausible alternative for landfill operator.

Alternative 2 requires the landfill operator 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. Therefore Alternative 2 is not a plausible alternative for landfill operator at present.

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

In conclusion, the practical and feasible baseline scenario is the Alterative 1, the landfill operator continues the current business as usual practice of not collecting and flaring landfill gas from the waste management operations.

**B.2. Description of how the methodology is applied in the context of the project activity:**

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The methodology will be applied for Option a), b) and c) of the Consolidated Methodology ACM0001, where the captured land fill gas is directly flared or used to produce energy and claim for part of the credits from displacing electricity from grid.

Specifically, the emission reduction will be calculated as follows:

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

The above equation is that of the Consolidated Methodology for Landfill Project ACM0001, where:

$ER_y$ : GHG emission reduction achieved by the project activity during a given year "y" ($tCO_2e$);

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

$MD_{reg,y}$ : Amount of methane that would have been destroyed/combusted during the year "y" in the absence of the Proposed Project activity ($tCH_4$);

$GWP_{CH4}$ : Approved Global Warming Potential value for methane ($21tCO_2e/t\ CH_4$);

$EG_y$ : Net quantity of electricity displaced during the year "y" (MWh);

$CEF_{electricity,y}$ : $CO_2$ emissions intensity of the electricity displaced during the year "y" ($tCO_2e$/MWh);

$ET_y$ : Quantity of thermal energy displaced during the year "y" (TJ);

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

As the Proposed Project doesn't conclude thermal production, the emission reduction of the Proposed Project will be calculated as follows:

$$ER_y = \left(MD_{project,y} - MD_{reg,y}\right) * GWP_{CH4} + EG_y * CEF_{electricity,y} \quad (2)$$

The electricity generated from the Proposed Project is supply to Shenzhen Grid and the electricity demand of the Proposed Project is supplied by the Shenzhen Grid. Shenzhen Grid is part of Guangdong Grid. The total planned installed capacity of the Proposed Project is about 8MW, and total capacity of all power consumers in the power generation system is no more than 2MW, both of them are lower than 15MW, therefore the carbon emission factor $CEF_{electricity,y}$ for the grid will be calculated according to the formulae for small scale electricity CDM project (Methodology for Small Scale Activities Type I.D.-Renewable Electricity Generation for a Grid), as shown below. Considering data availability, the carbon emission factor ( $CEF_{electricity,y}$ ) uses the weighted average emissions of the current generation

mix, using following equations:

$$CEF_{electricity,y} = \frac{\sum_{i,j} F_{i,j,y} * COEF_{i,j}}{\sum_{j} GEN_{j,y}} \quad (3)$$

Where:

$F_{i,j,y}$ : is the amount of fuel i (in GJ) consumed by power sources j in year y;

$j$ : is the power sources delivering electricity to the grid;

$COEF_{i,j}$ : is the carbon coefficient of fuel i ($tCO_2/GJ$);

$GEN_{j,y}$ : is the electricity (MWh) delivered to the grid by source j.

The data used for calculation of the weighted average emissions of Guangdong Grid is shown in Annex 3. The main source of data is China Electric Power Yearbook and China Energy Statistic Yearbook. The defaults used for calculation of calorific values for fuel types and fuel oxidization came from the Revised IPCC Guidelines 1996 and Coal-Based Diversified Clean Energy Strategy.

Since there is no regulatory or contractual requirements for landfill operator to specify $MD_{reg,y}$, an "Adjustment Factor" ( $AF$ ) is used to consider the amount of methane destroyed in the baseline scenario as follows:

$$MD_{reg,y} = MD_{project,y} * AF \quad (4)$$

Although project owner should provide an ex ante estimate of emissions reductions, by projecting the future GHG emissions of the landfill. Ex ante emission estimates may have an influence on $MD_{reg,y}$. $MD_{project,y}$ will be determined ex post by metering the actual quantity of methane captured and destroyed once the project activity is operational.

The amount of methane actually destroyed/combusted during the year "y" ( $MD_{project,y}$ ) is estimated as follows:

$$MD_{project,y} = Q_y \cdot f_{recover} \cdot EF_{recover} \cdot FE \quad (5)$$

Where:

$Q_y$ : is $CH_4$ generated in year y (t);

$f_{recover}$ : is the fraction of area covered by the operational collection system;

$EF_{recover}$ : is the collection efficiency;

$FE$ : is flare/combustion efficiency, determined by the operation hours and the methane content in the exhaust gas.

According to *IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories,* the *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC Guidelines)* outline two methods to estimate $CH_4$ emissions from solid waste disposal sites, the default method (Tier 1) and the First Order Decay (FOD) method (Tier 2). The main difference between the two methods is that the FOD method produces a time-dependent emission profile that better reflects the true pattern of the degradation process over time, whereas the default method is based on the assumption that all potential $CH_4$ is released in the year the waste is disposed of. The choice of a *good practice* method will depend on national circumstances. The Decision Tree for $CH_4$ Emissions from Solid Waste Disposal Sites in the *IPCC Guidelines* illustrates the process of choosing among methods. It is *good practice* to use the FOD method, if possible, because it more accurately reflects the emissions trend. Therefore, the First Order Decay (FOD) method (Tier 2) as follows is used to provide an ex ante estimate of emission reductions.

$$Q_y = \sum_x \left[ \left( A \cdot k \cdot MSW_T(x) \cdot MSW_F(x) \cdot L_0(x) \right) \cdot e^{-k(y-x)} \right] \quad (6)$$

Where:

$y$ : is year of inventory;

$x$ : is initial year to $y$, $x$ =1,2,… $y$ ;

$A$ : is normalization factor which corrects the summation, $A = \left(1 - e^{-k}\right) / k$ ;

$k$ : is methane generation rate constant (1/a);

$MSW_T(x)$: is the total municipal solid waste (MSW) generated in year $x$ (t/a)

$MSW_F(x)$: is the fraction of MSW disposed at SWDS in year $x$ ;

$L_0(x)$ : is the methane generation potential (t $CH_4$/t waste).

$$L_0(x) = MCF(x) \cdot DOC(x) \cdot DOC_F \cdot F \cdot 16/12 \quad (7)$$

Where:

$MCF(x)$: is the methane correction factor in year $x$ (fraction);

$DOC(x)$: is the degradable organic carbon (DOC) in year $x$ (fraction) (tC/t-waste);

$DOC_F$: is the fraction of DOC dissimilated;

$F$ : is the fraction by volume of $CH_4$ in LFG;

$16/12$ : is the conversion from C to $CH_4$.

$$DOC = (0.4 \cdot A) + (0.17 \cdot B) + (0.15 \cdot C) + (0.3 \cdot D) \quad (8)$$

Where:

$A$ : is the fraction of MSW that is paper and textiles;

$B$ : is the fraction of MSW that is garden waste, park waste or other non-food organic putrescibles;

$C$ : is the fraction of MSW that is food waste;

$D$ : is the fraction of MSW that is wood or straw.

**B.3. 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**:

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The additionality analysis of project scenario is done by using the Consolidated Tool for demonstration of additionality, which follows the following steps:

**Step 0: Preliminary screening of projects based on the starting date of the project activity**

The starting date of the Proposed Project is May 2005, when feasibility study report for the LFG collection and utilization system was finalized. The Proposed Project is not that type of project starting before the date of the first CDM project registered and prior to the start of the crediting period. CDM finance was considered from the beginning and the project owner has signed a legally-binding agreement on CDM project development with Beijing Sower Technology Development Co., Ltd in March 2005. (Available on DOE/DNA request.)

**Step 1: Identification of alternative to the project activity consist with current laws and regulations**

The objective of the Step 1 is to define realistic and credible alternatives to the project activity(s) that can be (part of) the baseline scenario through the following sub-steps:

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

Plausible and credible alternatives available to the Proposed Project include:

Alternative 1: The landfill operator could continue the current business as usual practice of not collecting and flaring LFG from the waste management operations.

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 a flaring system and a production system (to produce electricity, thermal energy or LFG upgraded CPLG).

***Sub-step 1b. Enforcement of applicable laws and regulations***

In the section B.1.1, the three alternatives to the Proposed Project activity are discussed in details with the conclusion that only Alternative 1 is the plausible alternative to the Proposed Project activity that can be the baseline scenario.

Refer to the *National Action Plan for Collection and Utilization of Landfill Gas (12/2001)*, the national code of *Technical Code for Sanitary Landfill of Municipal Domestic Refuse (CJJ17-2001)*, and the *Standard for Pollution Control on the Landfill Site for Domestic Waste (GB16889-1997）*, current priorities of the authorities are to prevent illegal dumping and to improve the conditions at "controlled" sites, which apply lower standards. Considering the great technical and economic barriers to upgrade existing landfills, it is unlikely to introduce mandatory LFG collection and utilization regulations in the foreseeable future.

As described above, the Proposed Project is not baseline scenario. Baseline scenario for the Proposed Project is Alternative 1: the landfill operator could continue the current business as usual practice of not collecting and flaring LFG from the waste management operations.

**Step 2: Investment analysis**

The purpose of this step is to determine whether the Proposed Project activity is economically or financially less attractive than other alternatives without the revenue from the sale of certified emission reductions (CERs). The investment analysis was done in the following steps:

***Sub-step 2a. Determine appropriate analysis method***

*Tools for the demonstration and assessment of additionality* suggests three analysis methods: simple cost analysis (option I), investment comparison analysis (option II) and benchmark analysis (option III).

Since the Proposed Project not only obtains CDM revenue but also revenue through sales of upgraded LFG, simple cost analysis method (option I) is not appropriate. Investment comparison analysis method (option II) is applicable to projects whose alternatives are similar investment projects. Only on such basis, comparison analysis can be conducted. The alternative baseline scenario of the Proposed Project is to continue the current business as usual practice rather than new investment projects. Therefore option II is not an appropriate method too. The Proposed Project will use benchmark analysis method based on the consideration that benchmark IRR and equity IRR of the Proposed Project and the business as usual practice are available to investors in the country.

***Sub-step 2b. Benchmark Analysis Method (Option III)***

The likelihood of development of the Proposed Project, as opposed to the continuation of current activities (i.e. no collection and flaring of LFG) will be determined by comparing its IRR with the benchmark of interest rate available to a local investor. In May 2005, interest rates for a five-year term of local banks in China are 3.6% for saving and 5.85% for loan. The interest rate for government bonds is up to 4.5%. The average returns from stock market and private equity funds are higher, which are about 11% and 13%, respectively.

Since the Proposed Project is an environmental protection project implemented by a private company, 12% is taken as financial benchmark rate of return (after tax).

***Sub-step 2c. Calculation and comparison of financial indicators***

Based on the feasibility study report of the Proposed Project, basic parameters for calculation of financial indicators are listed in Table 2.

**Table 2. Basic financial parameters of the Proposed Project**

| Item | Unit | Data | Notes |
|---|---|---|---|
| Static Total Investment | RMB million yuan | 12.60 | Of which:<br>Collection system: 5.20<br>LFG upgrade system: 7.40 |
| Equity capital | RMB million yuan | 3.70 | |
| Loan (1) | RMB million yuan | 3.70 | Payback in 10 years |
| Interest for loan (1) | % | 6.42 | |
| Loan (2) | RMB million yuan | 5.20 | Payback in 5 years |
| Interest for loan (2) | % | 5 | |
| O&M (includes Salary) | RMB million yuan /a | 2.74 | |
| LFG Price | RMB/$m^3$ | 0.1 | |
| Upgraded LFG Sale Income | RMB million yuan /a | 3.60 | 2.4 yuan/$m^3$ |
| CER Price | US$/ t-$CO_2$e | 6 | Exchange rate: US$1=8.10 yuan |
| Value Added Tax Rate | % | 17 | |
| Income Tax Rate | % | 33 | |
| Discount Rate | % | 10 | |
| Operation Period | Year | 25 | |

In accordance with benchmark analysis (Option III), if the financial indicators (such as IRR and NPV) of the Proposed Project are lower than the benchmark, the Proposed Project is not considered to be financially attractive.

For the Proposed Project, without CDM revenue, both IRR and NPV are negative, far below the selected financial benchmark. Thus the Proposed Project is not financially attractive without CDM revenue. With CDM revenue, the IRR and NPV of the Proposed Project are significantly improved. With CDM revenue, the Proposed Project can be considered to be financially attractive to investors.

***Sub-step 2d. Sensitivity analysis***

The objective of sensitivity analysis is to show whether the conclusion regarding the financial attractiveness is robust to reasonable variations in the critical 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.

For the Proposed Project, four financial parameters are taken as uncertain factors for sensitive analysis of financial attractiveness:

- Static total investment
- Annual O&M cost (includes salary)

- Upgraded LFG sale income

These parameters were selected as the most likely to fluctuate over time. Financial analyses are performed altering each of these parameters within the range of -10% to +10%. Though IRR of total investment of the Proposed Project varies to different extent, it keeps negative. To achieve IRR=12% without CDM revenue, it requires to remove all O&M cost (includes salary) or increase the upgraded LFG sale income by 100%. To keep normal operation of the project, it is impossible to remove all O&M cost (includes salary). The calculated price of CPLG is 2.4 yuan/$m^3$, equal to CNG price in the market, there is no space for the LFG sale income to increase much. Therefore the project activity is unlikely to be financially attractive without CDM revenue.

**Step 3. Barrier analysis**

This step is used to determine whether the Proposed Project activity faces real barriers that:

1) Prevent the implementation of this type of Proposed Project activity; and
2) Do not prevent the implementation of at least one of the alternatives.

Step 3 uses the following sub-steps:

***Sub-step 3a. Identify barriers that would prevent the implementation of type of the Proposed Project activity***

Establish that there are barriers that would prevent the implementation of the type of Proposed Project activity from being carried out if the Proposed Project activity was not registered as a CDM activity. These barriers include:

**(1) Investment barriers**

Investment of the technologies adopted by the Proposed Project is much higher. Since gas fuel has not widely used in Shenzhen city and the consumer has limited understanding of CPLG, CPLG also faces market barrier. Without CDM revenue, IRR of the Proposed Project is lower than benchmark IRR. In this case, the Proposed Project is not likely to attract commercial loan. Without the CDM revenue, it is difficult for the Proposed Project owner to achieve financial plan and the Proposed Project will face financing barriers. Only with the CDM revenue can loan be repayment and attractive financial return for investors be ensured. With CDM revenue, the Project Owner could speed up investment return, demonstrate CPLG as automobile fuel thus to promote construction and operation of larger scale of LFG utilization facilities in Xiaping Landfill.

**(2) Technology barriers**

Technological risk is associated with the adoption of the LFG upgrade to CPLG system which is technically advanced and for the first time to be commercially applied in China. Although the technology has been approved feasible and the project owner has got technology support from Department of Environmental Science and Engineering of Tsinghua University, the application of this technology still faces the risk resulted from the lack of skilled and/or

properly trained staff to operate and maintain the technology. Without CDM revenue, the project owner is lack of training and maintenance fund thus no incentive to implement the advanced technology. To continue current LFG uncontrolled release is the best option. Some of the CDM revenue can be used as a reserve for the operation and maintenance of the LFG upgraded to CPLG system and the training of staff, therefore enabling the project to overcome the technological barriers and to be implemented smoothly.

Above identified barriers are common to LFG collection and utilization projects in China and these are the main proof for demonstrating additionality.

***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)***

As mentioned in the section B.1.1 and Sub-step 1a, the three alternatives to the Proposed Project activity are discussed in details with the conclusion that Alternative 1 is the only plausible alternative to the Proposed Project activity that can be the baseline scenario, i.e. the landfill operator could continue the current business as usual practice of not collecting and flaring LFG from the waste management operations. Alternative 1 is in compliance with Chinese laws and regulations, without any investment or technological barrier etc.

**Step 4. Common practice analysis**

With the growing population and improved living standard, China has recognized the need to improve its waste management and has set a goal of disposing of 60% of municipal waste in sanitary landfills by 2000.

With the increasing of organic content of the waste, methane emission from landfills has become one of the fastest growing sectoral sources of GHG in China. The Ministry of Construction developed a comprehensive technical standard on municipal solid waste management in 1989. However, in general the standards were not followed due to investment and technology barriers. To date there has been limited development of LFG collection and utilization projects in China. For a quite large number of landfills, there exist problems such as have inappropriate or no cover system, limited or no compaction, no gas control system, etc[④].

China legislation does not require landfills to recover, utilize or dispose LFG. The municipal waste is disposed by using the technology of traditional landfills, without consideration of collection and utilization of LFG[⑤]. So far, very few landfills have been designed to collect and utilize (or even) flare the main body of LFG generated. Most of which are demonstration projects funded by development assistance resources. The Nanjing Tianjingwa LFG Electricity Project and Meizhou Landfills Gas Recovery and Utilization as Energy Project approved by China DNA have provided detail description on the importance of CDM revenue for certain type of projects.

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④ Source: Environmental Resource Management 2004, *China Waste Management Working Paper*

⑤ Source: National Action Plan for Collection and Utilization of LFG (12/2001)

**Step 5. Impact of CDM Registration**

The Proposed Project has not been put into operation. As shown in Step 2 above, in the absence of anticipated CDM revenue, the project owner is unlikely to move forward the Proposed Project in order to cut down investment losses. By taking this into account, the proposed project owner, Shenzhen Lisai Development Co., Ltd, has agreed to cooperate with Beijing Sower Technology Development Co., Ltd. for CDM project development. The cooperative agreement was signed in March 2005.

If the proposed project could be successfully registered at the EB, the CER sales revenue would supplement the sales income to gain investment return higher than that of the baseline scenario. The proposed project is the first project equipped with advanced LFG upgraded to CPLG system in China. The CDM revenues can be one of the sources for the technical maintenance and staff training reserve for the LFG upgraded to CPLG system that help the proposed project owner to mitigate financial risks, reduce technological risks so as to guarantee the reliable operation of the project and promote LFG utilization in Xiaping Landfill.

**Conclusion**

To summarize, it can be proved that the proposed project activity is not (part of) baseline scenario. Without support from CDM, the proposed project scenario would not occur. Instead, the landfill operator could continue the current business as usual practice of not collecting and flaring LFG from the waste management operations. As described in Step 2 and Step 3, the Proposed Project has strong additionality and can reduce the GHG emission. If the proposed project fails to be registered as a CDM project, this portion of emission reduction can not be realized. Based on the above analysis, it can be proved that the proposed project meets the additionality in the aspect of environment, investment and technology. The additionality analysis provides essential evidence that, the CDM revenue can enable the proposed project to overcome the barriers faced by LFG collection and utilization projects in China.

**B.4. Description of how the definition of the project boundary related to the baseline methodology selected is applied to the project activity:**

The project boundary shall encompass all anthropogenic emissions by sources of GHG under the control of the project participants that are significant and reasonably attributable to the CDM project activity. According to ACM0001 baseline methodology, the project boundary is the site of the project activity where the LFG will be captured and destroyed/used.

The following project activities and emission sources are considered within the project boundaries:

- $CH_4$ colleted from the landfill site. Considering that 10% of the site is still under filling, it is estimated that only 80% of the collection system is operated in average conservatively. With 60% collection efficiency of the collection system, 48% of LFG generated in the site will be captured.
- $CH_4$ emission from the automobile engines.

- $CO_2$ emission from the combustion of LFG in the flares and automobile engines. When combusted, methane is converted into $CO_2$. As the methane is organic in nature, the $CO_2$ released during the combustion process was originally fixed via biomass so that these emissions are not counted as project emissions. The life cycle $CO_2$ emissions of LFG are zero.
- $CO_2$ emission of the grid electricity for operation of the project activity.

A full flow diagram of the project boundary is presented in Figure 3 comprising all possible elements of the LFG collection system, flaring system and the LFG upgrade system.

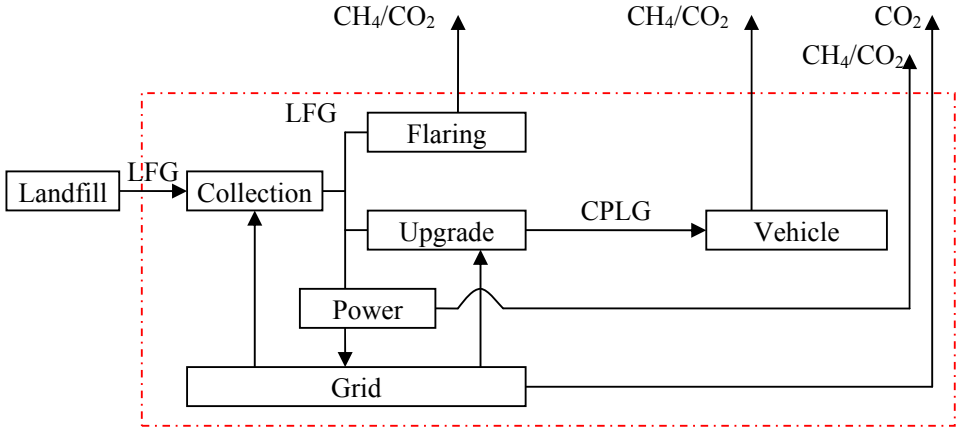


**Figure 3. Boundary of Shenzhen Xiaping Landfill Gas Collection and Utilization Project**

**B.5. Details of baseline information, including the date of completion of the baseline study and the name of person (s)/entity (ies) determining the baseline:**

The baseline study of the Proposed Project was completed on 15 October, 2005 by Ms. Pan Tao, assisted by Mr. Xia Zhenhua, Global Climate Change Institute, Tsinghua University, Energy Science Building-C, Tsinghua University, Haidian District, Beijing 100084, China.

The study of baseline and monitoring plan received a great support from Mr. Zhang Guangyu, General manager of Shenzhen Lisai Development Co., Ltd, Mr. Yang Zhigui, Chief Engineer of Shenzhen Xiaping Landfill and Prof. Wang Wei, Department of Environmental Science and Engineering, Tsinghua University.

## SECTION C. Duration of the project activity / Crediting period

### C.1 Duration of the project activity:

### C.1.1. Starting date of the project activity:

>>

01/02/2006

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

>>

25y-0m

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

### C.2.1. Renewable crediting period

>>

Not applicable

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

>>

Not applicable

### C.2.1.2. Length of the first crediting period:

>>

Not applicable

### C.2.2. Fixed crediting period:

### C.2.2.1. Starting date:

>>

01/02/2006

### C.2.2.2. Length:

>>

10 y-0m

**SECTION D. Application of a monitoring methodology and plan**

**D.1. Name and reference of approved monitoring methodology applied to the project activity:**

ACM0001 "Consolidated monitor methodology for landfill gas project activities". This consolidated monitor methodology is based on elements from AM0002, AM0003, AM0010, AM0011. For more information regarding the methodology please refer to http://cdm.unfccc.int/methodologies/approved.

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

The approved ACM0001 monitoring methodology shall be used in conjunction with the approved ACM0001 baseline methodology, which has been adopted by the Proposed Project.

The methodology ACM0001 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 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.

As previously described, the Proposed Project is based on three complementary activities, as follows:

- The collection and flaring of landfill gas, thus converting its methane content into CO2, reducing its greenhouse effect; and
- The upgrade and supply of CPLG as automobile fuel to the transportation vehicles of the Xiaping Landfill, thus converting its methane content into CO2, reducing its greenhouse effect and not claim emission reduction for displacing CPLG from other sources.
- The LFG power generation to supply electricity to Shenzhen Grid and claim emission reduction for displacing grid electricity, in converting its methane content into CO2 in internal-combustion engine, reducing its greenhouse effect.

The project therefore fulfils the conditions of Option a), b) and c) (i.e. the captured land fill gas is directly flared or used to produce energy and part of the credits from displacing grid electricity is claimed) so that ACM0001 monitoring methodology was considered the most appropriate methodology for the Proposed Project.

In line with ACM0001 monitoring methodology, Option 2 is chosen as the monitoring method.

**D.2. 1. Option 1: Monitoring of the emissions in the project scenario and the baseline scenario**

Not applicable.

**D.2.1.1. Data to be collected in order to monitor emissions from the project activity, and how this data will be archived:**

| ID number *(Please use numbers to ease cross-referencing to D.3)* | Data variable | Source of data | Data unit | Measured (m), calculated (c) or estimated (e) | Recording frequency | Proportion of data to be monitored | How will the data be archived? (electronic/ paper) | Comment |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
| | | | | | | | | |

**D.2.1.2. Description of formulae used to estimate project emissions (for each gas, source, formulae/algorithm, emissions units of CO2 equ.)**

**D.2.1.3. Relevant data necessary for determining the baseline of anthropogenic emissions by sources of GHGs within the project boundary and how such data will be collected and archived :**

| ID number *(Please use numbers to ease cross-referencing to table D.3)* | Data variable | Source of data | Data unit | Measured (m), calculated (c), estimated (e), | Recording frequency | Proportion of data to be monitored | How will the data be archived? (electronic/ paper) | Comment |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
| | | | | | | | | |

**D.2.1.4. Description of formulae used to estimate baseline emissions (for each gas, source, formulae/algorithm, emissions units of CO2 equ.)**

**D. 2.2. Option 2: Direct monitoring of emission reductions from the project activity (values should be consistent with those in section E).**

**D.2.2.1. Data to be collected in order to monitor emissions from the project activity, and how this data will be archived:**

| ID number *(Please use numbers to ease cross-referencing to table D.3)* | Data variable | Source of data | Data unit | Measured (m), calculated (c), estimated (e), | Recording frequency | Proportion of data to be monitored | How will the data be archived? (electronic/ paper) | Comment |
|---|---|---|---|---|---|---|---|---|
| 1. $LFG_{total,y}$ | Total amount of LFG captured | Measured by flow meter | m3 | m | Continuously/periodically | 100% | electronic | Data to be aggregated monthly and yearly. |
| 2. $LFG_{flare,y}$ | Amount of LFG flared | Measured by flow meter | m3 | m | Continuously/periodically | 100% | electronic | Data to be aggregated monthly and yearly. |
| 3. $LFG_{upgrade,y}$ | Amount of LFG upgraded to automobile fuel | Measured by flow meter | m3 | m | Continuously/periodically | 100% | electronic | Data to be aggregated monthly and yearly. |
| 4. $LFG_{electricity,y}$ | Amount of LFG used in power generation | Measured by flow meter | $m^3$ | m | Continuously/periodically | 100% | electronic | Data to be aggregated monthly and yearly. |
| 5. FE | Flare/combustion efficiency, determined by the operation hours (1) and the methane content in the exhaust gas (2) | Measured by gas quality analyzer | % | m | (1) Continuously<br>(2) Quarterly, if unstable | n/a | electronic | (1) Periodic measurement of methane content of flare exhaust gas.<br>(2) Continuous measurement of operation time of flare |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 6. $w_{CH4,y}$ | Methane fraction in the LFG | Measured by gas quality analyzer | $m^3CH4 / m^3LFG$ | m | Continuously/periodically | 100% | electronic | Calculated with daily average |
| 7. T | Temperature of LFG | Measured by online temperature sensor | °C | m | Continuously/periodically | 100% | electronic | Measured to determine the density of methane $D_{CH4}$. |
| 8. P | Pressure of LFG | Measured by online pressure sensor | Pa | m | Continuously/periodically | 100% | electronic | Measured to determine the density of methane $D_{CH4}$. |
| 9. $EG_y$ | Net electricity supplied to grid | Measured by ammeter | MWh | m | Continuously | 100% | electronic | Deduct power consumption. Required to determine $CO_2$ emission from use of electricity to operate the project activity |
| 10. $CEF_{electiricity,y}$ | $CO_2$ emission factor of the electricity in ID 8 | Calculated based on data from China Electric Power Yearbook. | $tCO_2$ /MWh | c | annually | 100% | electronic | Required to determine $CO_2$ emission from use of electricity to operate the project activity |
| 11 | Regulatory requirements relating to LFG projects | www.es.org.cn www.szepb.gov.cn | Test | n/a | annually | 100% | electronic | Required for any changes to the adjustment factor (AF) or directly $MD_{reg,y}$ |

**D.2.2.2. Description of formulae used to calculate project emissions (for each gas, source, formulae/algorithm, emissions units of CO2 equ.):**

The source of emission from the Proposed Project is the combustion of LFG in the flares and in the automobile engines. Methane is converted into $CO_2$ when combusted. As methane is organic in nature these emissions are not counted as project emissions. The $CO_2$ released during the combustion process was originally fixed via biomass so that the life cycle $CO_2$ emission of LFG is zero. The project, however, does not collect all the methane that is generated. Consequently, these emissions are excluded from the projections of emission reduction expected from the project. Furthermore, given that the emission reductions from this type of project are measured directly, there is no need to monitor project emission.

**D.2.3. Treatment of leakage in the monitoring plan**

**D.2.3.1. If applicable, please describe the data and information that will be collected in order to monitor leakage effects of the project activity**

| ID number *(Please use numbers to ease cross-referencing to table D.3)* | Data variable | Source of data | Data unit | Measured (m), calculated (c) or estimated (e) | Recording frequency | Proportion of data to be monitored | How will the data be archived? (electronic/ paper) | Comment |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
| | | | | | | | | |

The leakage of the Proposed Project is the emission of CPLG conbustion during transportation. Experiment shows that emission of bi-fuel automobile is equivalent to emission of gasoline automobile under similar conditions with less $CO_2$ and more HC. However given the HC emission is restricted according to Euro III requirement, the total emission of HC must be less than 0.2 g/km. There are about 200 automobiles in Xiaping Landfill, average running Kilometer Per Vehicle Per Day is 150 km, the total HC emission is about 2.19 tons, equivalent to 45.99 $tCO_{2e}$ per year. Compare to the emission reductions of the Proposed Project, this leakage could be neglected.

**D.2.3.2. Description of formulae used to estimate leakage (for each gas, source, formulae/algorithm, emissions units of $CO_2$ equ.)**

As described above, the Proposed Project can take no account of leakage, $L_y = 0$.

**D.2.4. Description of formulae used to estimate emission reductions for the project activity (for each gas, source, formulae/algorithm, emissions units of $CO_2$ equ.)**

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

The above equation is that in the Consolidated Methodology for Landfill Project ACM0001, where:

$ER_y$ : GHG emission reduction achieved by the project activity during a given year "y" ($tCO_{2e}$);

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

$MD_{reg,y}$ : Amount of methane that would have been destroyed/combusted during the year "y" in the absence of the Proposed Project activity ($tCH_4$);

$GWP_{CH4}$ : Approved Global Warming Potential value for methane (21 $tCO_{2e}$ /$tCH_4$);

$EG_y$ : Net quantity of electricity displaced during the year "y" (MWh);

$CEF_{electricity,y}$ : CO2 emissions intensity of the electricity displaced during the year "y" ($tCO_{2e}$ /MWh);

$ET_y$ : Quantity of thermal energy displaced during the year "y" (TJ);

$CEF_{thermal,y}$ : CO2 emissions intensity of the thermal energy displaced during the year "y" ($tCO_{2e}$ /TJ).

As the Proposed Project doesn't conclude thermal production, the emission reduction of the Proposed Project will be calculated as follows:

$$ER_y = \left(MD_{project,y} - MD_{reg,y}\right) * GWP_{CH4} + EG_y * CEF_{electricity,y} \quad (2)$$

The electricity generated from the Proposed Project is supply to Shenzhen Grid and the electricity demand of the Proposed Project is supplied by the Shenzhen Grid. Shenzhen Grid is part of Guangdong Grid. The planned total installed capacity is about 8MW. The total capacity of all power consumers in the power generation system is no more than 2MW, both of them are lower than 15MW, therefore the carbon emission factor $CEF_{electricity,y}$ for the grid will be calculated according to the formulae for small scale electricity CDM project (Methodology for Small Scale Activities Type I.D.-Renewable Electricity Generation for a Grid), as shown below. Considering data availability, the carbon emission factor ( $CEF_{electricity,y}$ ) uses the weighted average emissions of the current generation mix, using following equations:

$$CEF_{electricity,y} = \frac{\sum_{i,j} F_{i,j,y} * COEF_{i,j}}{\sum_j GEN_{j,y}} \quad (3)$$

Where:

$F_{i,j,y}$ : is the amount of fuel i (in GJ) consumed by power sources j in year y;

$j$ : is the power sources delivering electricity to the grid;

$COEF_{i,j}$ : is the carbon coefficient of fuel i (tCO2/GJ);

$GEN_{j,y}$ : is the electricity (MWh) delivered to the grid by source j.

The data used for calculation of the weighted average emissions of Guangdong Grid is shown in Annex 3. The main source of data is China Electric Power Yearbook and China Energy Statistic Yearbook. The defaults used for calculation of calorific values for fuel types and fuel oxidization, came from the Revised IPCC Guideline 1996 and Coal-Based Diversified Clean Energy Strategy.

Since there is no regulatory or contractual requirements for landfill operator to specify $MD_{reg,y}$, an "Adjustment Factor" ( $AF$ ) is used to consider the amount of methane destroyed in the baseline scenario as follows:

$$MD_{reg,y} = MD_{project,y} * AF \quad (4)$$

The amount of methane actually destroyed during the implementation of the Proposed Project is the sum of methane destroyed during flaring, upgrade and power generation. The amount of methane actually destroyed/combusted during the year "y" ( $MD_{project,y}$ ) is estimated as follows:

$$MD_{project,y} = MD_{flared,y} + MD_{upgraded,y} + MD_{electricity} \quad (9)$$

$$MD_{flared,y} = \left(LFG_{flared,y} + LFG_{upgrade,y} \times (1 - UE)\right) \times w_{CH4,y} \times D_{CH4} \times FE \quad (10)$$

$$MD_{upgrade,y} = LFG_{upgrade,y} \times w_{CH4,y} \times D_{CH4} \times UE \quad (11)$$

$$MD_{electricity,y} = LFG_{electricity,y} \times w_{CH4,y} \times D_{CH4} \times FE_{electricity} \quad (12)$$

Where:

$LFG_{flare,y}$ : is the amount of LFG flared in year y (m3/a);

$LFG_{upgrade,y}$ : is the amount of LFG upgraded to automobile fuel in year y ($m^3$/a);

$LFG_{electiricty,y}$ : is the amout of LFG combusted in internal combustion engine for power generation in year y (m3/a);

$\omega_{CH4,y}$ : is the methane fraction in the LFG, ($m^3CH_4$/ $m^3$LFG);

$D_{CH4}$ : is the density of methane under certain T (temperature of LFG) and P (pressure of LFG);

$FE$ : is flare/combustion efficiency, determined by the operation hours and the methane content in the exhaust gas, guaranteed by equipment supplier as higher than 99%;

$UE$ : is purified efficiency of the LFG upgrade to CPLG system, guaranteed by equipment supplier as higher than 92%.

## D.3. Quality control (QC) and quality assurance (QA) procedures are being undertaken for data monitored

| Data *(Indicate table and ID number e.g. 3.-1.; 3.2.)* | Uncertainty level of data (High/Medium/Low) | Explain QA/QC procedures planned for these data, or why such procedures are not necessary. |
|---|---|---|
| D.2.2.1-1 $LFG_{total,y}$ | Low | Two flow meters will be subject to a regular maintenance and testing regime to ensure accuracy. |
| D.2.2.1-2 $LFG_{flare,y}$ | Low | Two flow meters will be subject to a regular maintenance and testing regime to ensure accuracy. |
| D2.2.1-3 $LFG_{upgrade,y}$ | Low | Two flow meters will be subject to a regular maintenance and testing regime to ensure accuracy. |
| D2.2.1-4 $LFG_{electricity,y}$ | Low | Two flow meters will be subject to a regular maintenance and testing regime to ensure accuracy. |
| D2.2.1-5 FE | Medium | Regular maintenance will ensure optimal operation of flares. Flare efficiency should be checked quarterly, with monthly checks if the efficiency shows significant deviations from previous values. |
| D2.2.1-6 $w_{CH4,y}$ | Low | The gas analyzer should be subject to a regular maintenance and testing regime to ensure accuracy |
| D2.2.1-7 T | Low | The temperature sensor should be subject to a regular maintenance and testing regime to ensure accuracy |
| D2.2.1-8 P | Low | The pressure sensor should be subject to a regular maintenance and testing regime to ensure accuracy |
| D2.2.1-9 $EG_y$ | Low | The ammeter should be subject to a regular maintenance and testing regime to ensure accuracy |
| D2.2.1-10 $CEF_{electricity,y}$ | Low | According to national and local requirements. Data from China Electric Power Yearbook, China Energy Statistic Yearbook, Revised IPCC Guidelines 1996 and Coal-Based Diversified Clean Energy Strategy. Compared with other publications to control the difference lower than 5%. |
| D2.2.1-11 Regulatory requirements relating to LFG projects | Low | Appoint specific person in charge of scouting and collecting related documents under the DOE requirement. |
| D.2.2-1-12 $EF_{CH4}$ | Low | Appoint specific person in charge of periodically test and monitor. |
| D.2.2-1-13 L | Low | Appoint specific person in charge of data collection. |

**D.4 Please describe the operational and management structure that the project operator will implement in order to monitor emission reductions and any leakage effects, generated by the project activity**

The project owner has designated Mr.Zhang Guangyu, General Manager of Shenzhen Lisai Development Co., Ltd to be responsible for monitoring activities, includes:

- Installation of proven and qualified monitor equipment includes flow meter and gas quality analyzer.
- Construct a central control system which is connected with each of monitor equipment. The system will allow automated and continuous recording and reporting of data. The readings will be checked for any anomalies before being filed for future reference.
- Appoint qualified technicians to monitor and record data according to the monitoring plan. All the technicians will receive proper training to ensure they understand their specific tasks and handling of equipment. The records will be double checked by Mr. Zhang who will be responsible for accuracy and frequency of the measurements.
- Document data both in electronic version and hard copy in a transparent system. Receipt of electricity purchase will be obtained.
- Project owner will prepare verification report required by DOE and carbon buyers according to CDM rules and ERPA. Proper management process and routine procedures will be put in place to ensure the quality of reports. In the case of non-conformities in the implementation of the Proposed Project with relation to the monitoring plan, an analysis of non-conformity and its causes will be carried out immediately and corrective actions will be implemented.

Supported by the Project Owner, a CDM Handbook for the project owner to manage and monitor the proposed project is drafted at present. The manual is available for validation by the DOE and will be updated and revised based on the comments from the DOE.

**D.5 Name of person/entity determining the monitoring methodology:**

The monitoring plan study of the Proposed Project was completed on 15 October 2005 by Ms. Pan Tao, supported by Mr. Xia Zhenhua, Global Climate Change Institute, Tsinghua University, Energy Science Building-C, Tsinghua University, Haidian District, Beijing 100084, China.

The study of baseline and monitoring plan received a great support from Mr. Zhang Guangyu, General manager of Shenzhen Lisai Development Co., Ltd, Mr. Yang Zhigui, Chief Engineer of Shenzhen Xiaping Landfill and Prof. Wang Wei, Department of Environmental Science and Engineering, Tsinghua University.

## SECTION E. Estimation of GHG emissions by sources

### E.1. Estimate of GHG emissions by sources:

The source of emissions from the Proposed Project is the combustion of LFG in the flares and automobile engines. When combusted, methane is converted into $CO_2$. As the methane is organic in nature these emissions are not counted as project emissions. The $CO_2$ released during the combustion process was originally fixed via biomass so that the life cycle $CO_2$ emissions of LFG are zero. The project, however, does not collect all the methane generated. Consequently, these emissions are excluded from the ex ante estimation of emission reduction expected from the Proposed Project. Furthermore, given that the emission reduction from this type of project are measured directly, there is no need to monitor or ex ante estimate of project emissions.

### E.2. Estimated leakage:

No leakage needs to be accounted for this methodology.

### E.3. The sum of E.1 and E.2 representing the project activity emissions:

The sum of the Section E.1 and Section E.2 for the Proposed Project is zero.

### E.4. Estimated anthropogenic emissions by sources of greenhouse gases of the baseline:

ACM0001 provide an equation for calculating the amount of methane destroyed in the baseline scenario as follows:

$$MD_{reg,y} = MD_{project,y} * AF \quad (4)$$

Where:

$MD_{reg,y}$ : Amount of methane that would have been destroyed/combusted during the year "y" in the absence of the Proposed Project activity ($tCH_4$);

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

$AF$ : Adjustment factor (%).

The methane destroyed by the Proposed Project is estimated ex ante using the IPCC Fist Order Decay Model (Tier2), using the $L_0$ and $k$ values appropriate for the Proposed Project site and assuming that only 48% of the LFG generated is recovered (See Annex 3). Since the ex ante estimation is merely for illustrational purposes only, the actual emission reductions will be monitored directly. Further information on the parameters used please see Annex 3 of this document.

AF value is justified based on an estimation of the amount of LFG that would have been flared in the absence of the Proposed Project according to the effectiveness of the LFG collection system imposed by regulatory requirements at the time of inception of the Proposed Project (the 'Adjustment Factor'). The landfill operator is not required to flare any amount of LFG that currently emits. It is unlikely that the Chinese government will introduce legislation requiring the collection and flaring of LFG in the foreseeable future. Moreover, there are no wells in the Xiaping Landfill prior to the implementation of the Proposed Project. Therefore the AF value is zero for the Proposed Project. The emission reductions that would have taken place in the baseline scenario ( $MD_{reg,y}$ ) using the equation (4) is zero.

### E.5. Difference between E.4 and E.3 representing the emission reductions of the project activity:

Formulae for estimation of the amount of methane destroyed in the project scenario according to ACM0001 methodology as described in Section B.2 and Section D.2. The emission reductions of the Proposed Project are calculated using the following equation:

$$ER_y = \left(MD_{project,y} - MD_{reg,y}\right) * GWP_{CH4} + EG_y * CEF_{electricity,y} \quad (2)$$

For referring the summary of emission reductions that would have taken place in the project scenario ( $MD_{project,y}$ ) please see Annex 3 of this document.

## E.6. Table providing values obtained when applying formulae above:

The net reductions over the 10-year crediting period (from 2006 to 2015) are estimated to be: 5,741,878 $tCO_{2e}$. (Please refer to Annex 3 for the detailed tables which will be updated ex-post).

*The ex post calculation of baseline emission rates may only be used if proper justification is provided. Notwithstanding, the baseline emission rates shall also be calculated ex ante and reported in the CDM-PDD. The result of the application of the formulae above shall be indicated using the following tabular format.*

| Year | Estimation of emission reductions generated by the Project Activity ($tCO_{2e}$) | Estimation of baseline emission reductions ($tCO_{2e}$) | Estimation of leakage ($tCO_{2e}$) | Estimation of emission reductions ($tCO_{2e}$) |
|---|---|---|---|---|
| 2006 | - | - | 0 | 351,653 |
| 2007 | - | - | 0 | 397,961 |
| 2008 | - | - | 0 | 445,803 |
| 2009 | - | - | 0 | 495,534 |
| 2010 | - | - | 0 | 547,588 |
| 2011 | - | - | 0 | 598,836 |
| 2012 | - | - | 0 | 649,629 |
| 2013 | - | - | 0 | 700,393 |
| 2014 | - | - | 0 | 751,440 |
| 2015 | - | - | 0 | 803,041 |
| **Total ($tCO_{2e}$)** | - | - | 0 | **5,741,878** |

## SECTION F. Environmental impacts

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

An Environmental impact assessment was completed in accordance with Chinese regulation as part of the feasibility study for the Proposed Project and was approved by Environment Protection Bureau of Shenzhen in November 2005. Flowing environmental effects were identified for the Proposed Project and measures and procedures to mitigate the possible effects were provided based on the Ambient Air Quality Standard (GB3095-1996), the Integrated Wastewater Discharge Standard (GB8978-96), the Standard of Environmental Noise of Urban Area (GB3096-93), the Standard of Noise at Boundary of Industrial Enterprises (GB12348-90).

***Air Quality***
With periodically monitor, emission of the flaring gas will meet the leading emission criteria in the world such as in EU. Since the Proposed Project is sited in an open, even terrain and no companies or inhabitants within 300m range, the diluted flaring gas in atmosphere are viewed as almost no harm. Moreover, the implementation of the Proposed Project will significantly improve air quality of local area through avoiding uncontrolled release of LFG and odour and make contribution to protect global environment.

***Water Quality***
Waste water, generated mainly from the system of LFG upgrade to CPLG and equipment maintenance and repair, is concentrated in the disposal pool to remove dirty oil and then, discharged into sewer with no harm to environment.

***Noise***
There will be some increase in noise from the site associated with implementation of the Proposed Project, the application of pumps and Roots' blowers in LFG collection system and LFG upgrade system, the flow or ventilate of varies medium. Based on the requirements of the Standard of Environmental Noise of Urban Area (GB3096-93) and the Standard of Noise at Boundary of Industrial Enterprises (GB12348-90), following measures will be adopted to control and reduce noise:

- Establish sound insulation facilities between power plant and the control house to reduce noise impact on working condition;
- Install flexible connector, preserve heat for flue pipe and interpose reinforced rib in pipe to change vibration frequency of steel sheet, reduce flow noise and related vibration noise;
- Install silencer in input and output pipes;
- Install damping device in base of equipment to reduce vibration noise; and
- Periodically noise monitor for LFG collection, LFG upgrade to CPLG system and LFG power generation system and surroundings.

In conclusion, environmental impacts arising from this project are considered insignificant.

### F.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:

>>
Environmental impacts are not considered significant.

## SECTION G. Stakeholders' comments

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

>>

As required by National environmental protection regulations of PRC, the Project Owner should carry out public survey during EIA process to collect stakeholders' comments on the Proposed Project activities, therefore to guarantee the social and environmental benefits of the Proposed Project.

In September 2005, staff from the Project Owner carried out a survey of the stakeholders in the area where the Proposed Project will be sited. All the parties of pertinent benefit were inquired about the project actives through questionnaire and interview. Origin data is documented by the Project Owner and the main results are summarized as follows:

***Survey method***

Stakeholders' comments are collected through interview and public survey. The public survey is focused on local habitats and local employee. The interview is focused on officials of the responsible local government. The public survey and interview are conducted directly and stochastic to reflect public comments in an actual and impersonal view.

***Main Content***

- Public concern on pollution introduced by the Proposed Project;
- Public concern on environmental impacts introduced by the Proposed Project;
- Impact on local economic development and employment of the Proposed Project;
- Public attitude on the implementation of the Proposed Project;
- Other comments and suggestions regarding the Proposed Project (e.g. environmental protection).

***Informants Structure***

Totally 30 questionnaires were distributed and responses were collected through public survey. 60 percent of the informants of public questionnaire are highly educated. The interviewed officials are separately from Shenzhen Municipal Bureau for Urban Administration and Shenzhen Public Security Division.

### G.2. Summary of the comments received:

>>

With a complete understand, the local government provide written supporting letter to the Proposed Project, which is available for DOE/DNA.

The following is the summary of the key findings through public survey:

- 93.3% of the informants are not satisfied with current living conditions and surroundings mainly for the bad odor of the landfill.
- 60% of the informants support the implementation of the Proposed Project and 26.7% of the informants oppose. The main reason for opposition is that the landfill should not be located closed to residential area. This is not opposition to the Proposed Project.
- Among the positive impacts generated by the Proposed Project, "improvement of air quality" accounts for the highest percentage (73.3%), followed by "increase of living standard" (33.3), "increase of local employment" (20%) and "increase of income" (6.7%).
- Among the negative impacts mentioned, the main concerns were the increase of noise in construction period (70%). And 50%, 40%, 40% and 26.7% of the respondents deemed that "construction waste", "air pollution", "construction waste water" and "land-use impacts" are important to them, respectively. The Proposed Project is located in the landfill and 300m far from the boundary of the landfill, the landfill has capability on solid waste and waste water disposal, therefore the negative impacts is not obvious and will be ended accompany with the construction

completion.

- The stakeholders are care about environmental protection and have no opposite reason pointed to the construction and implementation of the Proposed Project.

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

During the construction and implementation of the Proposed Project, the Project Owner should attach importance to stakeholders' comments, seriously carry out environmental protection measures set in EIA and promote integrated benefits of environment, society and economy. The Proposed Project is in nature an environmental protection project and almost has no pollution. However, the public has no clear understanding on this, the Project Owner should enhance communication with the public. Since the local government and public show their support to the construction and implementation of the Proposed Project, therefore there is no need to modify the project due to the comments received.

## Annex 1

## CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

| | |
|---|---|
| **Organization:** | Shenzhen Lisai Development Co., Ltd |
| **Street/P.O.Box:** | Bagua Sanlu Street, Futian district |
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| **E-Mail:** | Ls_huanbao@163.com |
| **URL:** | http://www.szbaepb.gov.cn/kjcy/kjcy_031.asp |
| **Represented by:** | Zhang Guangyu |
| **Title:** | General Manager |
| **Salutation:** | Mr. |
| **Last Name:** | Zhang |
| **Middle Name:** | - |
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**The following are the contact details for the other Parties involved:**

| | |
|---|---|
| **Organization:** | Beijing Sower Technology Development Co., Ltd. |
| **Street/P.O.Box:** | No. Bing 33, Qinghuayuan Region, Haidian Districit |
| **Building:** | Room 4171, Sancaitang Building |
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| **Represented by:** | Deng Zhou |
| **Title:** | Project Manager |
| **Salutation:** | Mr |
| **Last Name:** | Deng |
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## Annex 2

## INFORMATION REGARDING PUBLIC FUNDING

There is no public funding for the Proposed Project.

## Annex 3

## BASELINE INFORMATION

**Table A1. Specific Parameters to Ex ante Estimate Methane Generation of the Xiaping Landfill**

| ID No. | Data Variable | Value | Data Source |
|---|---|---|---|
| $GWP_{CH4}$ | Approved GWP value for methane | 21 | ACM0001 |
| AF | Adjustment Factor | 0 | There are no wells before the implementation of the Proposed Project. |
| $f_{recover}$ | fraction of area covered by the operational collection system | 80% | Land filling area is about 10% of the Xiaping Landfill. Therefore the operational LFG collection system covers 90% of the total area. For conservativeness, take 80% for calculation. |
| $EF_{recover}$ | collection efficiency | 60% | Equipment supplier, data available for DOE/DNA. |
| FE | flaring efficiency in flaring system | 99% | Equipment supplier, data available for DOE/DNA. |
| UE | Purified efficiency of the LFG upgrade to CPLG system | 92% | Equipment supplier, data available for DOE/DNA. |
| $FE_{electricity,y}$ | Combustion efficiency in power plant | 99% | Sufficient combustion is achieved in domestic oil and gas power plants in which the oxidization rate can be deemed as 100%. Here take 99% as conservative. |
| A | normalization factor | 0.9341 | $A = \left(1 - e^{-k}\right)/k$ |
| k | methane generation rate constant | 0.138 | Feasibility Study Report of the Shenzhen Xiaping LFG Utilization Project |
| MCF(x) | methane correction factor in year x | 1.0 | According to classification criteria provided by the IPCC[1], Xiaping Landfill is a Managed SWDS[2] with default MCF value of 1.0. |
| DOC(x) | degradable organic carbon (DOC) in year x | 0.1482 | Based on equation (8) with test data below: |
| $DOC_F$ | fraction of DOC dissimilated | 55% | According to classification criteria provided by the IPCC, default value range of $DOC_F$ is 0.5 to 0.6. Considering high ratio of food waste in Xiaping Landfill with better degradation characteristics, midpoint (0.55) is conservatively adopted for $DOC_F$. |
| F | fraction by volume of $CH_4$ in LFG | 0.5 | Default range in IPCC 1996 (Revised) is 0.45-0.55. Take mid value as conservative. |
| $D_{CH4}$ | methane density | 0.0006 7 t/m$^3$ | Under 20℃ and standard atmosphere pressure (101,325 Pa) |

| | C | - | A | | D | - |
|---|---|---|---|---|---|---|
| | Food waste | Plastic | Paper | Textile | Wood/S traw | inorganic matter |
| Ratio (%) | 61.14 | 22.81 | 6.30 | 6.08 | 2.32 | 1.35 |

**Table A2. Total MSW Disposed in Year X in Xiaping Landfill**3 **($10^3$t)**

[1] *IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories, 5_waste*
[2] Managed SWDS must have controlled placement of waste (i.e. waste directed to specific deposition areas, a degree of control of scavenging and a degree of control of fires) and will include some of the following: cover material, mechanical compacting or leveling of waste.

| Year | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|---|---|
| $MSW_{filled}$ | 581 | 654 | 712 | 841 | 1016 | 1118 | 1207 | 1304 |
| **Year** | **2006** | **2007** | **2008** | **2009** | **2010** | **2011** | **2012** | **2013** |
| $MSW_{filled}$ | 1408 | 1521 | 1643 | 1774 | 1916 | 2012 | 2112 | 2218 |
| **Year** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** | **2021** |
| $MSW_{filled}$ | 2329 | 2445 | 2519 | 2594 | 2672 | 2752 | 2835 | 2920 |

Table A3 listed the LFG generated in year X in Xiaping Landfill.

**Table A3. LFG generated in year X in Xiaping Landfill ( t )**

| Year | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|---|---|
| Qy (t) | 3545 | 7078 | 10510 | 14286 | 18643 | 23061 | 27453 | 31870 |
| **Year** | **2006** | **2007** | **2008** | **2009** | **2010** | **2011** | **2012** | **2013** |
| Qy (t) | 36353 | 40947 | 45693 | 50626 | 55791 | 60875 | 65914 | 70950 |
| **Year** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** | **2021** |
| Qy (t) | 76014 | 81133 | 86044 | 90779 | 95380 | 99876 | 104299 | 108670 |

The data used for calculation of the weighted average emissions of Guangdong Grid is listed in table A4 and A5. The main sources of data are China Electric Power Yearbook and China Energy Statistic Yearbook (P218-221). The defaults used for calculation of calorific values for fuel types and fuel oxidization came from the Revised IPCC Guideline 1996 and Coal-Based Diversified Clean Energy Strategy. The weighted average emission factor ( $CEF_{electricity,y}$ ) is 0.7551 $tCO_{2e}$/MWh.

**Talbe A4. Basic data of Guangdong Grid in 2003[4]**

| Power generation technology option | | Year | Installed capacity (MW ) | Power generation (TWh) |
|---|---|---|---|---|
| Hydropower | Conventional | 2003 | 5707.2 | 14.930 |
| | Pumped storage | 2003 | 2400.0 | 2.206 |
| | Total | 2003 | 8107.2 | 17.136 |
| Fuel fired power | Coal-fired | 2003 | 17057.8 | 104.459 |
| | Oil-fired | 2003 | 10162.7 | 38.828 |
| | Gas-fired | 2003 | 0.0 | 0.0 |
| | Waste incineration | 2003 | 11.0 | 0.064 |
| | Total | 2003 | 27231.4 | 143.351 |
| Nuclear power | | 2003 | 3780.0 | 28.930 |
| Wind power | | 2003 | 83.4 | 0.159 |
| Total | | 2003 | 39202.0 | 189.576 |

**Table A5. Fuel consumption and GHG emissions of the Guangdong Grid in 2003**

| Fuel | Unit A | Consumption B | Emission Coefficient C (tC/TJ) | NCV D (TJ/A) | Emission E=BXCXDX44/12 ($tCO_{2e}$) |
|---|---|---|---|---|---|
| Raw coal | $10^3$t | 44917.9 | 24.74 | 209.08 | 85,192,833 |
| Clean coal | $10^3$t | 0.5 | 24.74 | 263.44 | 1,195 |
| Other coal gas | $10^6m^3$ | 321 | 20.2 | 522.7 | 124,274 |
| Crude oil | $10^3$t | 68.5 | 20 | 418.16 | 210,056 |

[3] Feasibility Study Report of Xiaping LFG Utilization Project

4 Data Resource: China Electric Power Yearbook 2004, P678-680.

| | | | | | |
|---|---|---|---|---|---|
| Gasoline | $10^3$t | 0.2 | 18.9 | 430.7 | 597 |
| Diesel | $10^3$t | 319 | 20.2 | 426.52 | 1,007,750 |
| Fuel oil | $10^3$t | 6272.2 | 21.1 | 418.16 | 20,291,599 |
| Refinery gas | $10^3$t | 28.5 | 20 | 460.55 | 96,255 |
| Other petroleum products | $10^3$t | 113.5 | 20 | 400.19 | 333,091 |
| Nature Gas | $10^6m^3$ | 451 | 15.3 | 3893.1 | 984,997 |
| Other Energy | $10^3$tce | 932.1 | 0 | 292.712 | 0 |
| **Total** | | | | | **108, 242, 647** |

Main electricity consumer of the Proposed Project includes five Roots' blower (30 KW/set, one reserve), one set of LFG upgrade system (270 KW) with one compressor (75 KW). Assuming the capacity of the related centre control system and monitor equipment is totally 25 KW, the total capacity of the Proposed Project is 1370 KW. Supposing all electricity consumers to be continuously operated throughout the year (8760 h/a) and the line loss of the Guangdong Grid is 8%[5]。

Calculated based on equation described in Section B.2 with the data above, the amount of methane generation, methane destroyed and emission reduction of the Proposed Project are shown in Table A6.

Please note: since the time schedule for the expansion of LFG to CPLG system and the operation of power plant is not confirmed, the calculation in Annex 3 only considers the first stage of LFG upgrade to CPLG system (500 m3/h) and the flaring system. Monitor report with actual emission reduction of the Proposed Project should be adjusted based on the actual conditions.

[5] It is pointed out in the Tenth-Five Plan of Power Industry that the national average line loss is 7% in year 2000. The line loss is decreased later on. Here take 8% as conservative.

**Table A6. Emission reduction of the Xiaping Landfill in Year X**

| Year | LFG ($Q_y$, t-$CH_4$) | LFG Collected ($Q_y$ *0.48, t-$CH_4$) | Methane destroyed in LFG upgrade to CPLG System ($MD_{upgraded,,y}$, t-$CH_4$) | Methane destroyed in Flaring System ($MD_{flared,,y}$, t-$CH_4$) | Methane destroyed in Power Plant ($MD_{electricity,y}$, t-$CH_4$) | Emission Reductions from net electricity generated (t-$CO_2e$) | Emission Reduction (t-$CO_2e$) |
|---|---|---|---|---|---|---|---|
| 2006 | 36,353 | 17,449 | 2,700 | 14,515 | 0 | -9,850 | 351,653 |
| 2007 | 40,947 | 19,654 | 2,700 | 16,720 | 0 | -9,850 | 397,961 |
| 2008 | 45,693 | 21,933 | 2,700 | 18,998 | 0 | -9,850 | 445,803 |
| 2009 | 50,626 | 24,301 | 2,700 | 21,366 | 0 | -9,850 | 495,534 |
| 2010 | 55,791 | 26,779 | 2,700 | 23,845 | 0 | -9,850 | 547,588 |
| 2011 | 60,875 | 29,220 | 2,700 | 26,285 | 0 | -9,850 | 598,836 |
| 2012 | 65,914 | 31,639 | 2,700 | 28,704 | 0 | -9,850 | 649,629 |
| 2013 | 70,950 | 34,056 | 2,700 | 31,121 | 0 | -9,850 | 700,393 |
| 2014 | 76,014 | 36,487 | 2,700 | 33,552 | 0 | -9,850 | 751,440 |
| 2015 | 81,133 | 38,944 | 2,700 | 36,009 | 0 | -9,850 | 803,041 |
| **Total** | **584,294** | **280,461** | **26,998** | **251,115** | **0** | **-98,501** | **5,741,878** |

## Annex 4

## MONITORING PLAN

Monitoring plan is a division and schedule of a series of monitoring tasks. Monitoring tasks must be implemented according to the monitoring plan in order to ensure that the real, measurable and long-term GHG emission reduction for the Proposed Project is monitored and reported.

### 1. What is required by the monitoring plan?

Managers of the Proposed Project must maintain credible, transparent, and adequate data estimation, measurement, collection, and tracking systems to maintain the information required for an audit of an emission reduction project. These records and monitoring systems are needed to allow the selected DOE to verify project performance as part of the verification and certification process. This process also reinforces that $CO_2$ reductions are real and credible to the buyers of the Certified Emissions Reductions (CERs).

Emission reductions will be achieved through avoided uncontrolled release of LFG of Landfill by the Proposed Project. The amount of the methane captured and destroyed by the Proposed Project and the 'Adjustment Factor' which defines baseline emissions are therefore defined as the key activities to monitor.

The monitoring plan provides the requirements and instructions for:
- Establishing and maintaining the appropriate monitoring systems for methane destroyed by the Proposed Project;
- Quality control of the measurements;
- Procedures for the periodic calculation of GHG emission reductions;
- Assigning monitoring responsibilities to personnel;
- Data storage and filing system;
- Preparing for the requirements of an independent, third party auditor/verifier.

### 2. Who uses the monitoring plan?

The Shenzhen Lisai Development Co. Ltd., the Proposed Project owner, will use this document as a monitoring guideline in realizing the project emission reduction credits and will adhere to the guidelines set out in this monitoring plan. This plan chould be modified according to actual conditions and requirements of DOE in order to ensure that the monitoring is credible, transparent and conservative.

### 3. Key definitions

The monitoring plan will use the following definitions of monitoring and verification.

- Monitoring: the systematic surveillance of the project's performance by measuring and recording performance-related indicators relevant in the context of GHG emission reductions.
- Verification: the periodic ex-post auditing of monitoring results, the assessment of achieved emission reductions and of the project's continued conformance with all relevant project criteria by a selected Designated Operational Entity.

### 4. Calibration of Meters & Metering

An agreement should be signed between the Proposed Project owner and the Xiaping Landfill, local grid company separately to define the metering arrangements and the required quality control procedures to ensure accuracy.

- The metering equipment will be properly calibrated and checked annually for accuracy and the metering equipment shall have sufficient accuracy so that error resulting from such equipment shall not exceed +0.5% of full-scale rating.
- Dual flow meters shall be jointly inspected and sealed on behalf of the parties concerned and shall not be interfered with by either party except in the presence of the other party or its accredited representatives.
- The electricity recorded by the Main Meters alone will suffice for the purpose of billing and emission reduction verification as long as the error in the Main Meter is within the permissible limits.

Calibration records will be maintained by the Proposed Project owner and the third party designated.

**5. Monitoring**

The monitor of the Proposed Project is focused on electricity input and output and methane destroyed. The meter reading will be readily accessible for DOE. Calibration tests records will be maintain for verification.

Data required for calculating the baseline emissions factor for Guangdong Grid is obtained from the China Electric Power Yearbook, China Energy Statistics Yearbook, Coal-Based Diversified Clean Energy Strategy and Revised IPCC Guideline 1996. The Proposed Project owner should collect and documented the latest China Electric Power Yearbook and China Energy Statistics Yearbook annually. If data for determining the baseline emission factor are no longer provided by the China Electric Power Yearbook and the China Energy Statistics Yearbook, the Proposed Project owner should notify the CDM developer of the Proposed Project or other qualified entity to redesign the access to obtain the data to calculate the conservative baseline emission factor of the project boundary.

The quality assurance and quality control procedures for recording, maintaining and archiving data shall be improved as part of this CDM project activity. This is an on-going process which will be ensured through the CDM mechanism in terms of the need for verification of the emissions on an annual basis according to this PDD and the CDM Handbook.

**6. Data Management System**

This provides information on record keeping of the data collected during monitoring. Record keeping is the most important exercise in relation to the monitoring process. Without accurate and efficient record keeping, project emission reductions cannot be verified. Below follows an outline of how project related records will be managed.

Overall responsibility for monitoring of GHG emissions reduction will rest with the CDM responsible person of the Proposed Project. The CDM manual sets out the procedures for tracking information from the primary source to the end-data calculations, in paper document format. If data and information are from internet, the website must be provided. Moreover, the credibility and reliability of those data and information from internet must be confirmed by the CDM developer or other qualified entities. It is the responsibility of the Proposed Project owner to provide additional necessary data and information for validation and verification requirements of respective DOE.

Physical documentation such as paper-based maps, diagrams, recipients and environmental impact assessment will be collated in a central place, together with this monitoring plan. In order to facilitate

auditor's reference, monitoring results will be indexed. All paper-based information will be stored by the Proposed Project owner and kept at least one copy.

The responsible person for the information management system for emissions reduction monitoring must be qualified as a statistician.

Table A7 below outlines the main documents relevant to monitoring and verification of the Proposed Project.

**Table A7. Main Documents on Monitoring and Verification**

| I.D. No. | Document Title | Main Content | Source |
|---|---|---|---|
| F-1 | PDD, including the electronic spreadsheets and supporting documentation (assumptions, estimations, measurement, etc.) | Calculation procedure of emission reduction and monitoring items | PDD in English and Chinese must be documented by the Proposed Project owner，or directly download from UNFCCC website |
| F-2 | Monitoring Quality Control and Quality Assurance Report | Equipment and national and industry standards | Proposed Project owner |
| F-3 | The report on qualifications of the persons responsible for the monitoring and calculation | i.e. the title of a technical post, working experience etc. | Proposed Project owner |
| F-4 | The report on monitoring and checking of methane destroyed, electricity input and output. | Record based on monthly meter reading and sale receipts of upgraded LFG, electricity. | Proposed Project owner |
| F-5 | Record on maintenance and calibration of metering equipment | Reasons for maintenance and calibration and the precision after maintenance and calibration | Proposed Project owner |
| F-6 | The report on baseline emission factor calculation | Data sources and calculation procedure | Proposed Project owner |
| F-7 | Record on emission reduction | Quarterly calculation | Proposed Project owner |
| F-8 | Letter of confirmation on F-2 to F-7 | Make confirmation of monitoring and calculation data and procedure from F-2 to F-7 | Proposed Project owner |
| F-9 | Project Management Record (including data collection and management system) | Comprehensively and truly reflect the management and the operation of the Proposed Project | Proposed Project owner |

## 7. Verification Procedure

The verification procedure of the monitoring results of the project is a mandatory process required for all CDM projects. The main objective of the verification is to independently verify that the Proposed Project has achieved the emission reductions as reported and projected in the PDD. It is expected that the verification could be done annually.

Main verification activities include:

- The Proposed Project owner should sign a verification service agreement with specific DOE and comply with the time framework set by CDM EB while consider of the buyer's schedule to carry out verification activities. The Proposed Project owner should prepare for and conduct verification activities with high efficiency and high quality.

- The Proposed Project owner should provide completed necessary information for verification to the DOE before and during verification activities.

- The Proposed Project owner should cooperate with the DOE and, instruct its staff and manager to be available for interviews and respond honestly to all questions relevant to verification from the DOE.

- If the Proposed Project owner deems that requirements of DOE beyond the scope of verification activities authorized by CDM EB, he should contact the CDM developer of the Proposed Project or other qualified entities to determine whether the requirements of DOE are reasonable. If the requirements are considered unreasonable, a rejection letter in a written format should be provided to the DOE with justifiable reasons. If the project owner and the DOE cannot reach an agreement on these requirements, the matter should be submitted to CDM EB or UNFCCC for arbitration.

The Proposed Project owner should designate a person in charge of the overall responsibility for the monitoring and verification procedure and act as the focal point for DOE.

## Annex 5

### List of key abbreviations

| | |
|---|---|
| CDM | Clean Development Mechanism |
| CDM EB | CDM Executive Board |
| CER | Certified Emission Reduction |
| $CO_{2e}$ | Carbon Dioxide Equivalent |
| CPLG | Compressed Purified Landfill Gas |
| DOE | Designated Operation Entity |
| ERPA | Emission Reduction Purchase Agreement |
| GHG | Greenhouse Gas |
| GWh | Gigawatt-hour |
| IRR | Internal Rate of Return |
| KWh | kilowatt-hour |
| Mt | million tonnes |
| MW | Megawatt |
| NCV | Net Calorific Value |
| RE | Renewable Energy |
| t | ton |
| tce | tons of standard coal equivalent |
| TWh | Terawatt-hour |
| VAT | Value-added Tax |

**Reference**

IPCC(2000). *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories*. http://www.ipcc-nggip.iges.or.jp/public/gp/english/

IPCC(1996). *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories*. http://www.ipcc-nggip.iges.or.jp/public/gl/invs1.htm

Project Design Document (PDD) of Nanjing Tianjingwa Landfill Gas to Electricity Project. Available from http://www.dnv.com/certification/climatechange/Projects/ProjectList.asp?Country=China

Project Design Document (PDD) of Meizhou Landfills Gas Recovery and Utilization as Energy Project. Available from http://www.dnv.com/certification/climatechange/Projects/ProjectList.asp?Country=China

*National Action Plan for Collection and Utilization of Landfill Gas (12/2001)*

*Technical Code for Sanitary Landfill of Municipal Domestic Refuse (CJJ17-2001)*

*Standard for Pollution Control on the Landfill Site for Domestic Waste (GB16889-1997）*

Waste Incineration Generation Technology, complied by Zhang Yanguo, published by Publishing House of China Water Conservancy & Hydropower, March 2004.