FY2008 CDM/JI Feasibility Study

Feasibility Study on Organic Waste Treatment and Methane Power Generation Project in Anhui, China (Digest Version)

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1 Project description

The proposed project plans to collect and sort municipal waste and agricultural waste generated in Guoyang County, Bozhou City, Anhui Province and will implement anaerobic treatment of organic waste to produce methane gas which will be used for power generation. The project is thus able to prevent methane emission from the landfill site and reduce damage to the environment through reduction of wastes. In addition, generated electricity will be supplied to the local grid.

Principal method currently used for waste treatment around the project area is landfill. In the project, “Waste sorting system and biogas power plant” developed by Nanjing Linhui Environment Protection Tec.Co.,Ltd, a host company, will be installed to treat organic waste anaerobically and to collect methane gas. Collected methane gas will be used for power generation and the residual waste of anaerobic treatment will be sold to the local farmers. In addition, other recyclable wastes will be sold to the recycling manufacturer.

Project site is located about 9km from the center of Guoyang, and Guoyang government is an owner of the land of the project site which is about 1,600m^2. Construction will start from March 2009 and the duration of the construction is expected to be about 16months. Host company has a pilot plant of the proposed project and the pilot test has been conducted since June 2008.

2 Implementation structure of the feasibility study

Organizations involved to the project are: Nanjing Linhui Environment Protection Tec.Co.,Ltd (Host Company) and three organizations who are responsible for development of CDM including JAPAN NUS Co., Ltd., Tsinghua University CDMR&D Center and Beijing CDM Science & Technology Consulting Company. Implementation structure of the project and roles of each organization are shown in Figure 1.

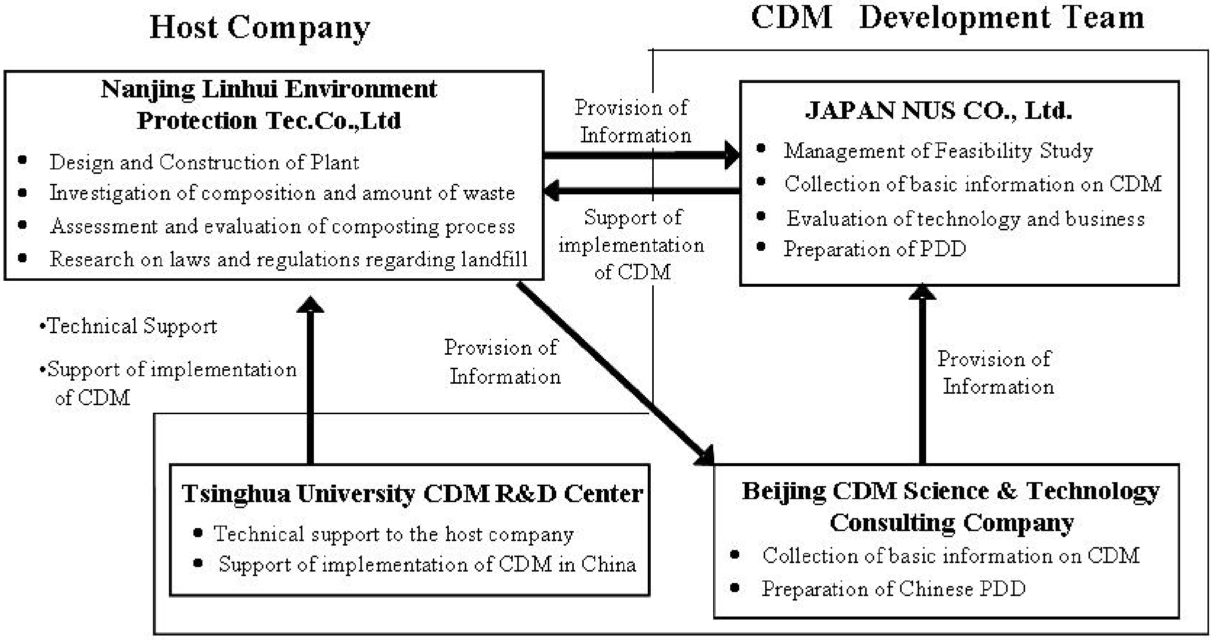

Figure 1 Implementation structure of the project and roles of each organization

3 Result of feasibility study

Information and data collected from the investigation includes, current situation of waste treatment in Guoyang, project equipment, data required for estimation of emission reduction, operation condition of the pilot plant, preparation status of monitoring equipment, and environmental impact assessment. We also conducted investigation on reliability of the FS report provided by the host company and informed about the monitoring method to the host company.

Total annual amount of waste generated in Guoyang in 2007 was about 84,000t and it is expected to rise to 139,000t in 2020.Guoyang will therefore need to treat about 400t of waste daily in near future. In the landfill site currently used in Guoyang, wastes are simply piled up without management of wastewater or landfill gas emission, and it leads to the problem of odor.

In order to collect methane gas from anaerobic treatment of organic waste, it is necessary to sort organic waste from the mixed municipal wastes. The host company has developed waste sorting system and has acquired patent for it. Capacity of the sorting system is 400t per day, and the collected municipal waste is sorted into several different materials; (1) rubber, paper, fabric, metal and glass, (2) rubble and sand, (3) battery and fluor lamp, (4) plastic, (5) organic waste.

Sorted recyclable waste will be sold to the recycling manufacturer and other harmless wastes will be sent to the landfill. Organic waste together with wastewater will be sent to the anaerobic digester. Residual waste of anaerobic digestion will go through composting process and will be sold to local farmers. Methane gas generated from anaerobic digestion will be utilized for electricity generation and the electricity will be sold to the grid. In addition, waste heat generated from power generator will be used for drying of residual waste in the composting process. Figure

2 shows outline of waste sorting system and methane gas power generation plant used in the project.

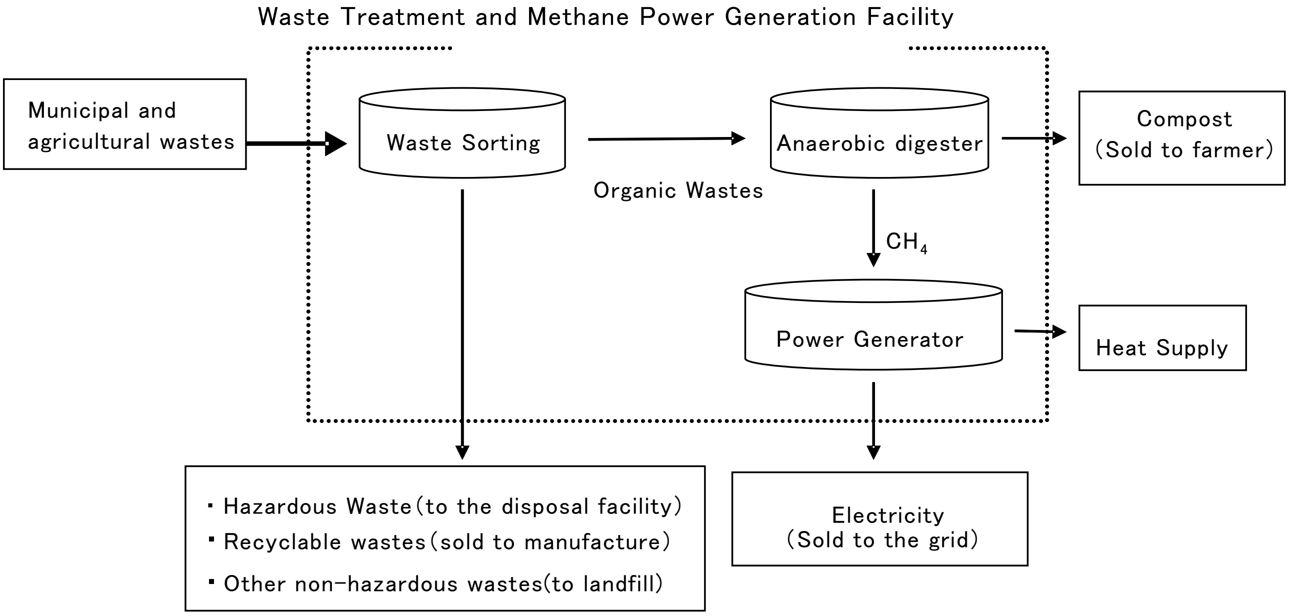

Figure 2　Outline of waste sorting and methane gas power generation plant used in the project

The concentration of methane gas generated in anaerobic digester is approximately 55-60%. Collected methane gas will be dehydrated and desulfurized, and then sent to a gas storage tank. Gas leakage detectors will be installed to the anaerobic digester. When they detect leakage, operation of the anaerobic digester will be stopped manually to avoid leakage. Gas leakage detector is also installed to the gas storage tank. When there was leakage from gas tank, supply of gas from the anaerobic digester to the gas tank will be stopped and the gas will be flared.

Methane gas stored in the gas storage tank will be sent to a gas engine through a pipeline. Two 500kW of gas engine will be used for power generation. All generated electricity will be sold to local grid at 0.62RMB for 1kW. List of electricity consumption of each equipment used in the project was provided by the host company, and thus emission reduction by displacement of grid electricity can be calculated by subtracting the amount of electricity used for the project activity from the amount of electricity sold to the grid.

Residual waste collected from the anaerobic digester will be dehydrated and sent to the compost manufacturing facility where rotary dryer will dry residual waste at three different stages. Dried compost will be mixed with fertilizer (N,P,K) and will be made into pellets.

4　Methodology and applicability

The methodology applied to the project is AM0025 “Avoided emissions from organic waste through alternative waste treatment processes (Version. 10.1) ” . The methodology is applicable to the project activity involving one or combination of the following waste treatment options for the fresh waste that would have otherwise been disposed of in a landfill: (1) A composting process in aerobic conditions, (2) Gasification to produce syngas and its use, (3) Anaerobic digestion with biogas collection and flaring and /or its use, (4) Production of refuse-derived fuel (RDF) / stabilized biomass (SB), (5) Incineration of fresh waste for energy generation, electricity and /or heat. The project is applicable to "(3) Anaerobic digestion with biogas collection and flaring and /or its use". Emission reduction activity for the project includes avoidance of emission of methane which would have been emitted if the organic waste is disposed of in landfill site. Moreover, supply of generated electricity to the grid can be regarded as displacement of electricity generated with fossil fuel and thus counted as CO_2 emission reduction.

To estimate the amount of methane emission avoided from landfill site by the project, "Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site (Ver.4)" has been used.

5 Project boundary

AM0025 defines project boundary as the site of the project activity where the waste is treated. This includes the facilities for processing the waste, onsite electricity generation and/or consumption, onsite fuel use, thermal energy generation, wastewater treatment plant and landfill site. The project boundary does not include facilities for waste collection, sorting and transport to the project site. The project boundary based on this definition is shown in Figure 3.

The flow chart below shows the main components and connections included in the system boundary of the project.

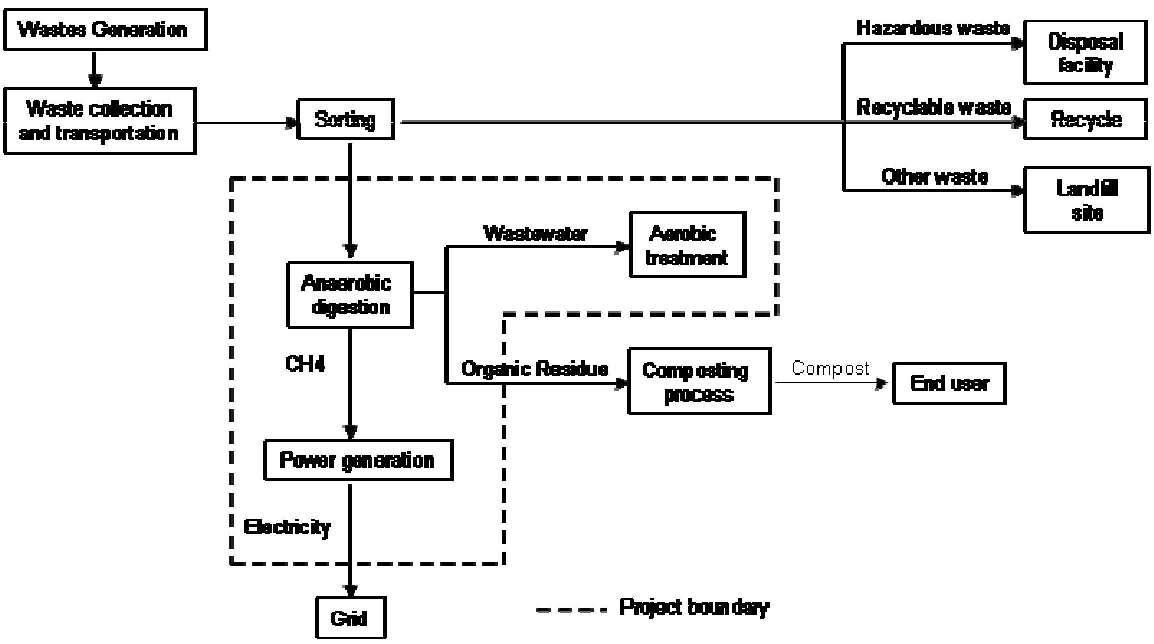

Figure 3 Outline of the project boundary of the project

6 Project period and Crediting period

Guoyang government is expecting that population of Guoyang will increase in near future as a result of the urbanization plan. This will lead to increase of waste generation. The host company is planning to upgrade of waste treatment technology to cope with this change and expecting that waste treatment business in the area will continue to develop. Designed lifetime of the project plant is 15 years and the construction period is 16months. Therefore the project period is 17 years from March 2009 when the construction will start. Crediting period is 10 years from January 2011 when the plant will start its operation.

7 GHG Emission Reduction

Table 1 shows Baseline Emissions (BE), Project Emissions (PE), Leakage (L) and GHG Emission Reduction of the project. Expected GHG emission reduction of the project during the crediting period is 225,461tCO_2.

Table 1 BE, PE, L and GHG Emission Reduction（Unit: tCO_2）

Year	Baseline Emissions		Project Emissions	Leakage	GHG Emission Reduction
	$BE_{CH4,SWDS,y}$	$BE_{elec,y}$	$PE_{a,l,y}$	$L_{N2O,y}$	
2011	5,020	878	4,741	156	1,001
2012	9,945	985	4,918	162	5,850
2013	14,920	1,161	5,209	171	10,700
2014	19,735	1,235	5,333	176	15,462
2015	24,673	1,446	5,682	187	20,250
2016	29,560	1,576	5,898	194	25,044
2017	34,400	1,704	6,111	201	29,793
2018	39,151	1,810	6,287	207	34,468
2019	43,949	1,985	6,577	216	39,141
2020	48,607	2,049	6,683	220	43,754
Total	269,960	14,829	57,438	1,890	225,461

8 Monitoring Plan

Table 2 lists essential monitoring parameters of the project required by AM0025. Prior to the start of the project, we will carry out investigation of the result of pilot test from the pilot plant, review of the monitoring procedure. Establishment of QA/QC will also be discussed with the host company.

Table2 Monitoring parameters for the project

Parameter	Description
$EG_{PJ,FF,y}$	Amount of electricity used by the project activity
$EG_{d,y}$	Amount of electricity displaced by the project activity
$F_{cons,y}$	Amount of fossil fuel consumption by the project activity
$M_{a,y}$	Amount of methane produced from anaerobic digester
$SG_{a,y}$	Stack gas volume from the power generator (1) Inflow of biogas（Amount of biogas flows into the power generator） (2) Flow rate (Amount of air required for combustion in the power generator) (3) Temperature (Temperature of stack gas) (4) Operating hours (Annual operating hours of power generator)
$MC_{N2O,a,y}$	Concentration of N_2O in stack gas
$MC_{CH4,a,y}$	Concentration of CH_4 in stack gas
$A_{j,x}$	Amount of organic waste *j* avoided from landfill in year *x*
$p_{n,j,x}$	Weight fraction of the waste type *j* in the sample *n* collected during the year *x*
z	Number of samples collected during the year *x*
$RATE^{Compliance}_{y}$	Rate of compliance on management of municipal waste at national level
$S_{OD,LE}$	Number of samples of oxygen deficiency (＜10%)
$S_{LE,total}$	Total number of samples taken per year

9 Environmental Impact and other indirect impact

Environmental Impact Assessment of the facilities for waste treatment, anaerobic digestion, power generation and other relating process has been conducted in accordance with Chinese law of environmental impact assessment. Approval of the construction from the local government has already been granted and the host company is currently waiting for the result of review of environmental impact assessment. The review is expected to finish by the end of March 2009.

Biogas produced and collected from anaerobic treatment of organic wastes contains CH_4 (about 55%), CO_2 (about 44%) and H_2S (about 0.034%). Collected methane will be stored in the storage tank and managed to prevent leakage until used as fuel for power generation. H_2S will be removed by desulfurization equipment. Wastewater will be treated aerobically and reused in the project site and for agriculture and it will therefore minimize wastewater discharged to the environment. Consequently, impact of the project to the environment is expected to be negligible.

10 Economic Analysis

Revenue from the sales of CER is significant as it will greatly improve profitability of the project. IRR of the project without revenue from sales of CER was 7.38%, which is lower than the sectoral benchmark IRR against total investment for electricity generating industry. On the other hand, revenue from the sales of CER (*9Euro/CER, 1Euro = 10JPY) improves IRR of the project to 13.69%. Therefore, it is hard for the proposed project to acquire business license without CDM, i.e. the business license will be granted if the implementation of CDM is assured.

11 Co-benefits Effects in the host country

While China is experiencing rapid economic growth in late years, “Three wastes problem” i.e. wastes, waste water and waste gas (atmospheric pollution) has been becoming serious issue. The current situation of landfill sites in China is that they do not meet the international design standard or environmental standard due to lack of technology and finance. In particular, in rural area where road has not been constructed or maintained, wastes cannot even be collected and transported to the landfill site, so that field heaping of the wastes is common practice. This situation causes damage to the landscape, odor, air/soil/water pollution etc.

The project would contribute to solve this problem by utilizing organic wastes for methane power generation and composting. Proper implementation of separate collection of waste could also prevent accumulation of harmful materials in the landfill site and promote recycling of wastes. As a result, landfill wastes could be less harmful and reduce total amount of waste sent to the landfill site. Therefore, the project is expected to generate the following co-benefits: (1) Prevention of environmental pollution (e.g. damage to the landscape, odor, air/soil/water pollution), (2) Convenient collection of illegal dumping, (3) Recycling of wastes, (4) Reduction of waste sent to the landfill site, and (5) Contribution to the local farmers through supply of compost.

The amount of CER obtained from the Project which targets emission reduction of CH_4 is relatively small. However, the project becomes attractive by considering other revenue such as sales of recyclable wastes and compost. Moreover, waste management project like this will greatly contribute to the improvement of local environment. Implementation of this type of project should therefore be promoted.

12 Issues and Tasks for Project Materialization

One of the difficulties of the project is that there are a number of monitoring parameters, for which selection and preparation of appropriate instrument is crucial. Furthermore, it is necessary to consider some changes to the design of the plant with implementation of the instrument. Sampling of the organic waste for the investigation of component and the measurement of oxygen concentration in the residual waste have to be done regularly and manually, and thus it becomes a burden to the host company. The result of the feasibility study will be fed back to the host company and they will use these results and result of pilot test to improve the design of the project plant.

The waste sorting system of the project is able to process maximum 400t of wastes per day. This is equivalent to 146,000t per year. However, the amount of waste treated during the crediting period is expected to be less than maximum capacity of waste treatment. Therefore, we would like to investigate the possibility of collecting more wastes.

In the estimation of GHG emission reduction, it is required to choose most applicable values for the parameters provided by the methodology and "Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site". The amount of emission reduction varies significantly with the value selected. Parameters that are difficult to choose the appropriate value includes DOC_j which is used to estimate $BE_{CH4,SWDS,y}$ and leakage of methane from anaerobic digestion which is needed for estimation of $PE_{a,l,y.}$

DOC_j is the rate of content of Degradable Organic Carbon contained in organic waste, and its value varies depending on whether organic waste is "Wet" or "Dry". Since the amount of emission reduction will be smaller when choosing "Wet", "Wet" is the preferred choice when the condition of waste is unknown as it is conservative. In the proposed project, because the climate condition used to determine the rate of decomposition of organic waste (k_j) was "Dry", "Dry" was chosen for the status of organic waste. However, if this choice cannot be accepted by the DOE, "Wet" has to be chosen for DOC_j and the amout of emission reduction would decrease significantly.

Fraction of CH_4 leakage emissions from the anaerobic digesters is selected from the following options: monitoring the actual quantity of the gas leakage (Option 1), applying an appropriate IPCC physical leakage default factor which is 15% (Option 2) and applying a physical leakage factor of zero where advanced technology used by the project activity prevents any physical leakage (Option 3). In this study, Option 2 which is conservative choice was selected. However, there is a possibility that Option 3 could be applied to the project plant, and this will result in increase of the amount of GHG emission reduction.

Figure 3 shows the amount of emission reduction and IRR for four different scenarios with different DOC_j and CH_4 leakage. A scenario selected for the present study is "15% leakage +

DOC_j = Dry". In any cases, IRR is above 8% and thus acquisition of the business license should have no problem. However, considering the cost for validation, registration and other expenses, cost-effectiveness of the project should be seriously considered especially for those scenarios with small expected GHG emission reduction.

Table 3 Emission reduction and IRR estimated from different scenario of DOC_j and CH_4 leakage

Calculation Scenario	Total emission reduction of 10years （tCO_2）	IRR （%）
15% leakage + DOC_j = Dry	225,461	13.69
15% leakage + DOC_j = Wet	76,433	9.66
0% leakage + DOC_j = Dry	282,899	15.37
0% leakage + DOC_j = Wet	132,087	11.46