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

CONTENTS

Annexes

SECTION A. General description of project activity

A.1 Title of the project activity:

>> The title of the project activity: Methane Recovery and Utilization CDM Project at Muyuan Swine Farm in Henan Province

The current version number of the document: Version 3.0

The date of the document was completed: 20/12/2006

A.2. Description of the project activity:

>> The proposed project activity is to collect methane from swine manure treatment at Muyuan Livestock Feeding Co., Ltd., Neixiang County, Henan Province (hereafter refer to as Muyuan) which consists six subsidiary swine farms-Gangtou, Hexi, Laozhuang, Maping, Shuitian and Fangang. The proposed project treats the raw manure and wastewater from 188,500 swine annually by anaerobic digester, and uses the biogas generated during the treatment process for power generation. After anaerobic digestion, the wastewater is treated aerobically and then is used for agriculture irrigation. Therefore, the reduction, resource utilization, harmlessness and ecological utilization of the manure from the swine farm can be realized. Total installed capacity of the proposed project is 1.09MW, the electricity generated are all used by the swine farms. Meanwhile, as the main component of the biogas is methane (CH_4) which is an important greenhouse gas (GHG), so the project activity can effectively reduce the greenhouse gas emissions.

Muyuan adopt Upflow Anaerobic Sludge Bed Reactor (UASB) and Internal Circulation Anaerobic Reactor (IC) as its anaerobic digester technologies, the methane generated during the manure treatment process are collected and utilized. This kind of technology can control the flow direction of the pollutants during the production process and prevent the animal themselves from being polluted, then diseases can be controlled and the “swine-biogas-crops” pattern can be realized without draining of wastewater, so this technology has a bright future.

The project activity can contribute to local sustainable development in the following aspects:

- The project activity can enhance the quality of the water, control the odour, and improve the working environment of the workers and the production and living conditions of the farmers.
- The project activity can provide more than 20 job opportunities for local residents.
- The effluent and slurry are good organic fertilizers which are all supplied to the farmers living around free, they can be used to yield organic products and improve the income of the farmers.
- Biogas technology can capture the methane generated during the treatment process and use biogas to generate electricity which can provide clean energy to substitute some traditional energy resource, thus the project can reduce CH_4 emission more effectively and contribute to the mitigation of global climate change.

A.3. Project participants:

>> The following table lists the project participants and the parties involved:

Name of Party involved (*) ((host) indicates a host Party)	Private and/or public entity(ies) project participants (*) (as applicable)	Kindly indicate if the Party involved wishes to be considered as project participant (Yes/No)
People's Republic of China (host)	• Muyuan Livestock Feeding Co., Ltd., Neixiang County, Henan Province.	No
Japan	• Marubeni Corporation	No
(*) 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.		

Detailed contact information of the project participants is given in Annex 1.

A.4. Technical description of the project activity:

A.4.1. Location of the project activity:

>> The proposed project is located in Neixiang County, Henan Province, PRC, which is at 111°33′～112°09′ east longitude and 32°49′～33°35′ north latitude.

A.4.1.1. Host Party(ies):

>> People's Republic of China

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

>> Henan Province

A.4.1.3. City/Town/Community etc:

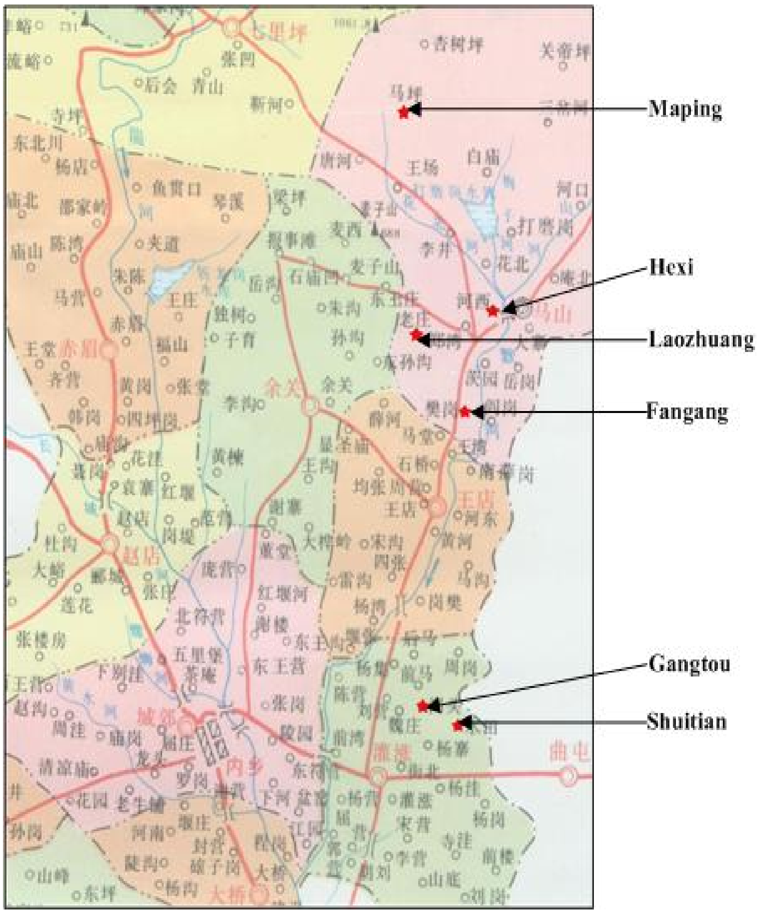
>> Neixiang County

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

>> The proposed project activity is located in Neixiang County, Henan Province, which is at 111°33′～112°09′ east longitude and 32°49′～33°35′ north latitude, it is 68km far from Nangyang City. There are six subsidiary farms involved in the project of which the distance between the two farthest farms (Maping and Shuitian) is 35 km. The location of the project site is shown in figure 1 and figure 2.

Figure 1 Location of Neixiang County

Figure 2 Location of the proposed project activity



Note: The asterisks in figure 2 show the project site of the swine farms.

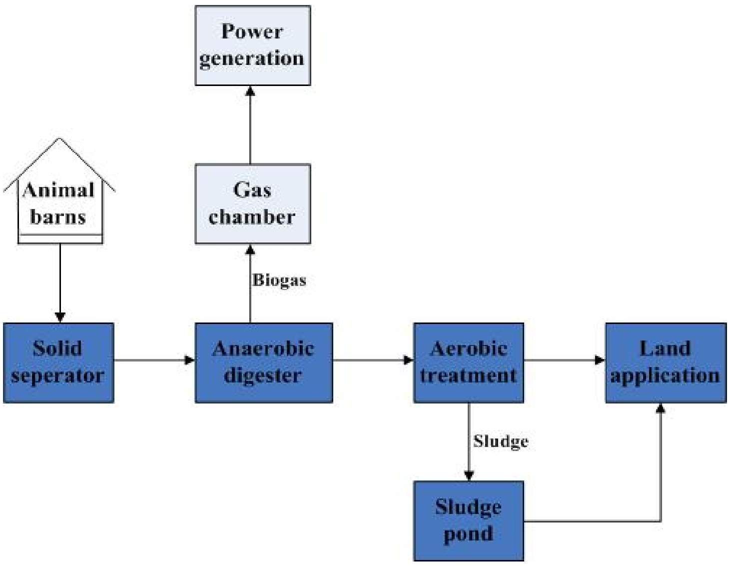
A.4.2. Category(ies) of project activity:

>> The proposed project activity falls into sector 13-waste treatment and disposal, and sector 15-agriculture.

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

>> After the mixture of manure and water in Muyuan is separated by the solid separator, the wastewater is anaerobically digested at first, the biogas generated from the anaerobic digester is stored in the gas chamber after being desulphurized as well as desiccated and is used to generate electricity for daily operation of Muyuan. After anaerobic digestion, the wastewater is treated aerobically and then is used for agriculture irrigation. The sludge produced during the aerobic treatment process is used as high quality fertilizer. The effluent and slurry are all supplied to the farmers living around free. The technical flow of the project activity is shown below:

Figure 3 Technical flowchart of the proposed project activity



The wastewater in Muyuan is first pre-treated via the centrifugal solid separator to get rid of most suspended solids. There are two types of anaerobic digester technology used in the project activity, i.e. Upflow Anaerobic Sludge Bed Reactor (UASB) and Internal Circulation Anaerobic Reactor (IC). The diameter of the UASB Reactor is 14m, its height is 14m. The diameter of the IC Reactor is 3.6～7m, its height is 23m. The aerobic treatment system used in the project activity is aeration oxidation pond. The 6160Q generators made by Weichai Peterson Gas Diesel Engines Company Limited are used for power generation.

All technologies utilized in the project activity are domestic technologies and there will be no international technology transfer involved in this project.

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

>> The estimated emission reductions of the proposed project activity are 110,461 tCO_2e per year during the crediting period of 10 years.

Years	Annual estimation of emission reductions in tons of CO_2e
2007.4.1～2007.12.31	82,846
2008	110,461
2009	110,461
2010	110,461
2011	110,461
2012	110,461
2013	110,461
2014	110,461
2015	110,461
2016	110,461
2017.1.1～2017.3.31	27,615
Total estimated reductions (tons of CO_2e)	**1,104,610**
Total number of crediting years	**10**
Annual average over the crediting period of estimated reductions (tons of CO_2e)	**110,461**

A.4.5. Public funding of the project activity:

>> There is no Official Development Assistance (ODA) from Parties included in Annex I involved in this project activity.

SECTION B. Application of a baseline and monitoring methodology

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

>> The approved methodology applied by this project is referenced as ACM0010 (Version 02) “Consolidated methodology for GHG emission reductions from manure management systems”.

According to the requirements of ACM0010, “Tool for the demonstration and assessment of additionality (Version 02)” agreed by CDM Executive Board is used during the additionality demonstration and assessment process of the project activity.

For more information please refer to the UNFCCC CDM-Executive Board website under the following link:

http://cdm.unfccc.int/methodologies/PAmethodologies/approved.html

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

>> The approved methodology ACM0010 is applicable to manure management systems with the following conditions:

- Farms where livestock populations, comprising of cattle, buffalo, swine, sheep, goats, and/or poultry, is managed under confined conditions;
- Farms where manure is not discharged into natural water resources (e.g. rivers or estuaries);
- In case of anaerobic lagoons treatments systems, the depth of the lagoons used for manure management under the baseline scenario should be at least 1m;

- The annual average temperature in the site where the anaerobic manure treatment facility in the baseline existed is higher than 5°C;
- In the baseline case, the minimum retention time of manure waste in the anaerobic treatment system is greater than 1 month;
- The AWMS/process in the project case should ensure that no leakage of manure waste into ground water takes place, e.g., the lagoon should have a non-permeable layer at the lagoon bottom.

Muyuan livestock feeding company is a large-scale private owned swine farm in which swines are managed under confined conditions and the manure is not discharged into natural water resources, the depth of the anaerobic lagoon in the baseline scenario is 17m, the annual average temperature at the project site is 15.3℃, the minimum retention time of manure in the anaerobic lagoon is far more than 1 month, and the lagoons of the AWMS in the project case have non-permeable layer at the lagoon bottom which can ensure that no leakage of manure waste into ground water takes place. Since the proposed project activity meets all the applicability conditions of the methodology, the methodology ACM0010 is applicable for this project activity.

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

>> Figure 4 describe the project boundary of the project activity:

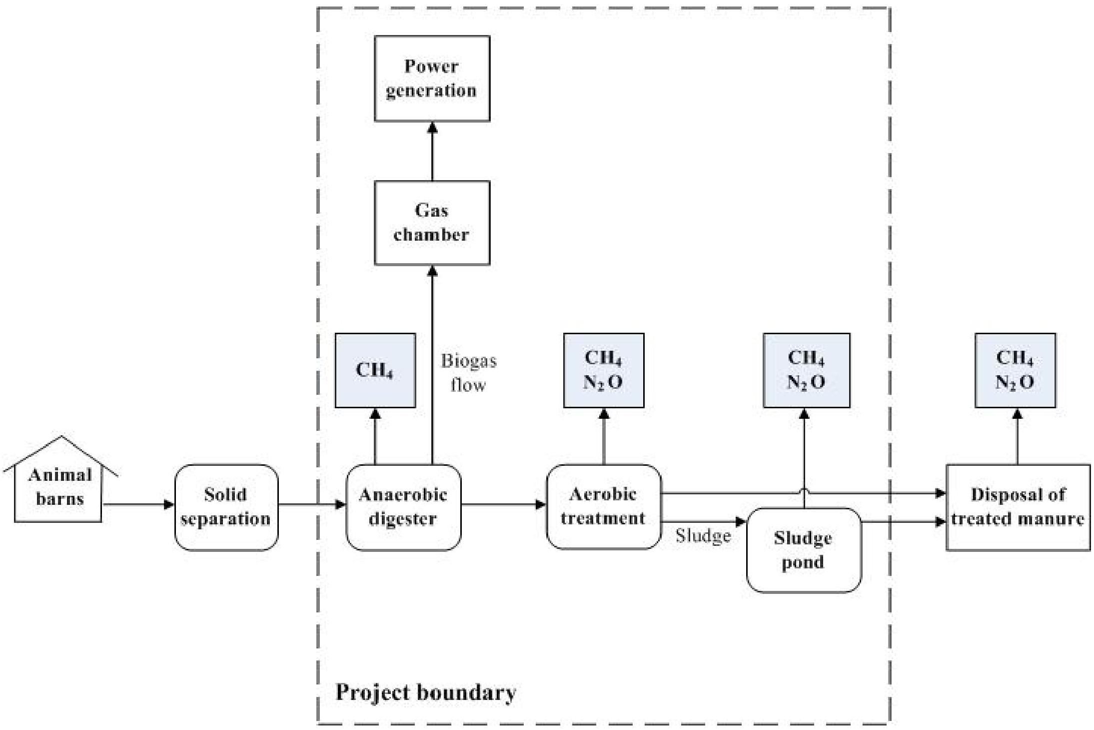


Figure 4 Project boundary of the project activity

The following table describes the emission sources and gases which are included in the project boundary of the baseline scenario and the project activity:

	Source	Gas	Included?	Justification /Explanation
Baseline	Direct emissions from the uncovered anaerobic lagoon	CH_4	Included	The major source of emissions in the baseline.
		N_2O	Included	
		CO_2	Excluded	CO_2 emissions from the decomposition of organic waste are not accounted.
	Emissions from electricity consumption	CO_2	Excluded	The anaerobic lagoon does not consume electricity.
		CH_4	Excluded	The anaerobic lagoon does not consume electricity.
		N_2O	Excluded	The anaerobic lagoon does not consume electricity.
	Emissions from thermal energy generation	CO_2	Excluded	The anaerobic lagoon does not consume thermal energy.
		CH_4	Excluded	The anaerobic lagoon does not consume thermal energy.
		N_2O	Excluded	The anaerobic lagoon does not consume thermal energy.
Project Activity	Emissions from thermal energy generation	CO_2	Excluded	The project activity does not consume thermal energy.
		CH_4	Excluded	The project activity does not consume thermal energy.
		N_2O	Excluded	The project activity does not consume thermal energy.
	Emissions from onsite electricity use	CO_2	Excluded	Because electricity is generated from collected biogas in the project activity, these emissions are not accounted for.
		CH_4	Excluded	Because electricity is generated from collected biogas in the project activity, these emissions are not accounted for.
		N_2O	Excluded	Because electricity is generated from collected biogas in the project activity, these emissions are not accounted for.
	Direct emissions from the anaerobic digester process	N_2O	Excluded	Excluded for simplification. This emission source is assumed to be very small.
		CO_2	Excluded	CO_2 emissions from the decomposition of organic waste are not accounted.
		CH_4	Included	The major source of emission in the project activity.
	Direct emissions from the aerobic treatment process	N_2O	Included	
		CO_2	Excluded	CO_2 emissions from the decomposition of organic waste

				are not accounted.
		CH_4	Included	There are minor CH_4 emissions from aerobic treatment.
	Direct emissions from the sludge pond	N_2O	Included	Emissions due to denitrification.
		CO_2	Excluded	CO_2 emissions from the decomposition of organic waste are not accounted.
		CH_4	Included	Emissions due to possible anaerobic conditions.

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

>> The methodology ACM0010 determines the baseline scenario through the following steps:
Step I: Define alternative scenarios to the proposed CDM project activity;
Step II: Barriers analysis;
Step III: Investment analysis;
Step IV: Baseline revision at renewal of crediting period.

Step I：Define alternative scenarios to the proposed CDM project activity

Identify realistic and credible alternative scenarios that are available either to the project participants or to other potential project developers for managing the manure. These alternative scenarios should include:
(1) Aanaerobic Digester-Aerobic Treatment i.e. the proposed project activity not being registered as a CDM project activity
(2) Solid Storage
(3) Dry Lot
(4) Liquid/Slurry
(5) Pit Storage below animal confinements
(6) Deep Bedding
(7) Composting
(8) Uncovered Anaerobic Lagoon

Apply Sub-step 1b of "Tool for demonstration assessment and of additionality (Version 02)". Eliminate alternatives that are not in compliance with all applicable legal and regulatory requirements.

(1) Anaerobic Digester-Aerobic Treatment i.e. the proposed project activity not being registered as a CDM project activity
Anaerobic digester-Aerobic Treatment system is considered to be one of the most advanced manure management systems in the world. Only a few countries have implemented such technology because of the high costs involved in the investment compared to other available systems. There has been no application of this system in Henan province. The China Government has established a set of laws, regulations and policies to encourage and promote the development of renewable energy resources, but the investment analysis presented in step III indicates that the anaerobic digester system is not a financial attractive project due to its high costs without the income from CDM, and the investors don't interest in it. Therefore, (1) is not a realistic and credible alternative.

(2) Solid Storage
This system is not applicable for manure that has low solid content. The swine manure waste in this project is liquid and should be pumped from the barns to the waste treatment systems. Moreover, this system is not efficient enough for odour and pathogen control. So the exclusion of this potential baseline scenario can be justified.

(3) Dry Lot
This system is excluded because it is not applicable to the conditions of Muyuan barns which incorporate the use of floor slabs.

(4) Liquid/Slurry
Since the amount of discharged manure is very large even on a daily bases, storing the liquid manure in the tank to distribute them to the farmland requires a lot of labour work. Therefore it is unrealistic to implement such a task for this project under the competition of the market. Therefore this option faces significant barrier and is excluded from the baseline scenario.

(5) Pit Storage below animal confinements
Muyuan is a large-scale livestock farm and the manure quantity produced is too large to implement pit storage structure under the barns, so this scenario is excluded. Moreover, the excreted volume accumulated under the barns produces enteric fermentation gas, if it is not discharged out of the barns in time, the pigs will be quickly killed by the accumulation of toxic fumes.

(6) Deep bedding
The deep bedding is laborious and this is counter to achieving economies of scale associated with large animal counts. The concentration of nocuous gas in the bedding is high enough to poison pigs if it is disposed inappropriately, and it is favourable for the survival and breeding of vermin and microorganisms due to its high temperature and humidity. So, the deep bedding practice is excluded from consideration. This system is more applicable to small scale farms.

(7) Composting
Composting systems are not adapted to manure possessing large volumes of water, or moisture contents. This dry aerobic system can only be applied after solid separation stages of activated sludge. For this reason, it is excluded from the list of plausible scenarios.

(8) Uncovered Anaerobic Lagoon
This system represents the most common practice in China at present time, and it is also considered to be the most economical, efficient, and reliable manure management system. The “Discharge standard of pollutants for livestock and poultry breeding (GB18596)” requires the livestock farms to meet wastewater discharge standards before discharging the wastewater into the natural water resources. In order to meet this regulation, the common practice in swine farms is to build anaerobic lagoons for wastewater treatment. There is no legal requirement for the anaerobic lagoons to be covered to prevent methane emission.

Step II：Barriers analysis

Investment barriers: Anaerobic digester system is considered to be one of the most advanced manure management systems in the world. Only a few countries have implemented such technology because of the high costs involved in the investment compared to other available systems. Additionally, the investment required to generate electricity from biogas is still too high and the cost is much higher than electricity prices in the market, so the IRR of the project activity is lower than the average level and it is difficult for the project proponents to get loans from the banks. Only the project proponents can prove that they can get CERs revenues from the CDM projects, it can attract the banks to provide loans for this project. For these reasons, without the CERs revenues companies are willing to adopt other manure management systems of lower costs which will lead to more GHG emissions.

Technological barriers: Anaerobic digester system has to be sized to handle projected animal volumes, this system will become progressively more expensive on a ‘per animal’ basis when the farm size is smaller. The daily operation involved in this technology includes a detailed monitoring program to monitor various parameters of the system. Moreover, most companies are short of professional labour on technology and maintenance, corresponding equipment maintenance system and accessory supply system, so it often causes equipment disrepair and malfunction. The uncovered anaerobic lagoon system is technologically simple and easy to operate and maintain, so the project activity is additional compared to the baseline scenario from a technology perspective.

Based on the above analysis, only the uncovered anaerobic lagoon is not prevented from being implemented by these barriers, and it is the most possible baseline. In other worlds, the identified barriers would not prevent the implementation of at least one of the alternatives, that is the alternative (8) uncovered anaerobic lagoon.

Step III：Investment analysis

Undertake investment analysis of all the alternatives that don't face any barriers, as identified in Step II. For each alternative, all costs and economic benefits attributable to the waste management scenario should be illustrated in a transparent and complete manner.

Total investment of the project activity is 18 million Yuan, of which 6 million is equity fund and the rest is loans from the domestic commercial banks. The lifetime of the project activity is 15 years. Its operation costs mainly include maintenance costs, material costs, labour costs and loan interest expenses. Total installed capacity of the project activity is 1.09MW, the annual utilization time of the generator is 5760 hours, and the local electricity price is 0.62Yuan/kWh. The electricity generated from the biogas is used for the company's daily operation, so it can save the electricity costs of the company. Table 1 and table 2 show the investment analysis results of the uncovered anaerobic lagoon and the project activity (assuming that 1US$ equal to 8RMB).

Table 1 Investment analysis of the uncovered anaerobic lagoon (US$)

Costs and benefits	2005	2006	2007-2020
Initial investment costs	-50,000	-25,000	0
Operation costs	-875	-3,500	-5,250
Net cash flow	-50,875	-28,500	-5,250
NPV (discount rate =10%)	**-101,767**		
IRR (%)	无定义		

Table 2 Investment analysis of the CDM project activity without revenues from sale of CERs (US$)

Costs and benefits	2005	2006	2007-2015	2016-2019	2020
Initial investment costs	-1,500,000	-750,000	0	0	0
Operation costs	0	-169,299	-244,299	-225,000	-225,000
Cost saving from electricity purchase	0	214,272	486,576	486,576	486,576
Salvage	0	0	0	0	52,500
Net cash flow	-1,500,000	-705,027	242,277	261,576	314,076
NPV (discount rate =10%)	**-434,211**				
IRR (%)	**6.17%**				

There are no potential revenues involved in the baseline scenario. The revenues generated by the project activity include revenues from cost savings due to avoided electricity purchases but not include revenues from the sale of CERs. There are only negative flows in the baseline scenario, so the Internal Rate of

Return (IRR) can not be calculated and the economic comparison should be based on the Net Present Value (NPV) indicator. Table 3 summaries the results of financial analysis for each scenario.

Table 3 NPV comparison (US$)

	Uncovered anaerobic lagoon	CDM project activity
NPV (discount rate=10%)	-101,767	-434,211

As shown in table 3, the NPV of both the project activity and the uncovered anaerobic lagoon are negative and the NPV of the project activity is far more negative than that of the uncovered anaerobic lagoon which means the cost of the project activity is much higher than the uncovered anaerobic lagoon, so the uncovered anaerobic lagoon is the most attractive course of action and is considered to be the baseline scenario, it is determined that the project activity is additional compared to the chosen baseline scenario from an economic perspective.

The FIRR of the project activity without CDM support is lower than the industry benchmark that is 8%, so the project activity lacks financial attraction. If the project activity can get the revenues from the sale of CERs (assuming that the CERs price is 10US$/t$CO_2$e and the crediting period is 10 years), its FIRR can improve to 33.12% which is higher than the benchmark, so it will be attractive to investors.

Table 4 Financial analysis of CDM project activity with revenues from sale of CERs (US$)

Costs and benefits	2005	2006	2007	2008-2015	2016	2017	2018-2019	2020
Initial investment costs	-1,500,000	-750,000	0	0	0	0	0	0
Operation costs	0	-169,299	-244,299	-244,299	-225,000	-225,000	-225,000	-225,000
Cost saving on electricity purchases	0	214,272	486,576	486,576	486,576	486,576	486,576	486,576
Revenues from sale of CERs	0	0	828,458	1,104,610	1,104,610	276,153	0	0
Salvage	0	0	0	0	0	0	0	52,500
Net cash flow	-1,500,000	-705,027	797,344	982,366	1,001,665	537,729	261,576	314,076
NPV (discount rate =10%)	**3,265,055**							
IRR (%)	**33.12%**							

Step IV：Baseline revision at renewal of crediting period

The crediting period adopted in the project activity is fixed crediting period, so this step is not applicable.

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

>> The baseline determination process has demonstrated that the baseline is different from the proposed project activity not undertaken as a CDM project activity, it is concluded that the project is additional.

B.6. Emission reductions:

B.6.1. Explanation of methodological choices:

>> The emission reductions of the project activity are calculated according to the following methods:

(1) Baseline emissions

$$BE_y = BE_{CH4,y} + BE_{N2O,y} + BE_{elec/heat,y} \quad (1)$$

where,

BE_y : Baseline emissions in year y, in tCO_2e/year.

$BE_{CH4,y}$: Baseline methane emissions in year y, in tCO_2e/year.

$BE_{N2O,y}$: Baseline N_2O emissions in year y, in tCO_2e/year.

$BE_{elec/heat,y}$: Baseline CO_2 emissions from electricity and/or heat used in the baseline in year y, in tCO_2e/year. Because the anaerobic lagoon does nor consume electricity and heat, these emissions are not accounted for.

(i) Methane emissions

$$BE_{CH4,y} = GWP_{CH4} \cdot D_{CH4} * \sum_{j,LT} MCF_j * B_{0,LT} * N_{LT} * VS_{LT,y} * MS\%_{Bl,j} \quad (2)$$

where,

$BE_{CH4,y}$: Annual baseline methane emissions in tCO_2e/year.

GWP_{CH4} : Global Warming Potential (GWP) of CH_4.

D_{CH4} : CH_4 density (0.00067 t/m^3 at room temperature (20 ºC) and 1 atm pressure).

MCF_j : Annual methane conversion factor (MCF) for the baseline $AWMS_j$ from IPCC 2006 Guidelines, table 10.17, chapter 10, volume 4.

$B_{0,LT}$: Maximum methane producing potential of the volatile solid generated, in m^3 CH_4/kg-dm, by animal type LT.

N_{LT} : Number of animals of type LT for the year y, expressed in numbers.

$VS_{LT,y}$: Annual volatile solid for livestock LT entering all AWMS [on a dry matter weight basis](kg-dm/animal/year).

$MS\%_{Bl,j}$: Fraction of manure handled in system j.

Estimation of various variables and parameters for above equations:

(A) $VS_{LT,y}$ can be determined in one of the following ways, stated in the order of preference:

1. Using published country specific data. If the data is expressed in kg-dm per day, multiply the value with nd_y (number of days in year y).

2. Estimation of VS based on dietary intake of livestock

$$VS_{LT,y} = \left[GE_{LT} * \left(1 - \frac{DE_{LT}}{100}\right) + \left(UE * GE_{LT}\right) \right] * \left[\left(\frac{1 - ASH}{ED_{LT}} \right) \right] * nd_y \quad (3)$$

where:

$VS_{LT,y}$: Annual volatile solid excretion on a dry matter weight basis (kg-dm/year).

GE_{LT} : Daily average gross energy intake in MJ/day.

DE_{LT} : Digestible energy of the feed in percent (IPCC 2006 defaults available).

$UE*GE_{LT}$: Urinary energy expressed as fraction of GE. Typically 0.04GE can be considered urinary energy excretion by most ruminants (reduce to 0.02 for ruminants fed with 85% or more grain in the diet or for swine). Use country-specific values where available.

ASH : Ash content of manure calculated as a fraction of the dry matter feed intake. Use country-specific values where available.

ED_{LT} : Energy density of the feed in MJ/kg (IPCC notes the energy density of feed, ED, is typically 18.45 MJ/kg DM, which is relatively constant across a wide variety of grain-based feeds.) fed to livestock type LT. The project proponent will record the composition of the feed to enable the DOE to verify the energy density of the feed.

nd_y : Number of days in year y where the treatment plant was operational.

3. Scaling default IPCC value $VS_{default}$ to adjust for a site-specific average animal weight as shown in equation below:

$$VS_{LT,y} = \left(\frac{W_{site}}{W_{default}}\right) \cdot VS_{default} \cdot nd_y \quad (4)$$

where,

$VS_{LT,y}$: Adjusted volatile solid excretion per year on a dry-matter basis for a defined livestock population at the project site in kg-dm/animal/year.

W_{site} : Average animal weight of a defined population at the project site in kg.

$W_{default}$: Default average animal weight of a defined population in kg from where the data on $VS_{default}$ is sourced (IPCC 2006 or US-EPA, which ever is lower).

$VS_{default}$: Default value (IPCC 2006 or US-EPA, which ever is lower) for the volatile solid excretion per day on a dry-matter basis for a defined livestock population in kg-dm/animal/day.

nd_y : Number of days in year y where the treatment plant was operational.

4. Utilizing published IPCC defaults, multiply the value with nd_y (number of days in year y).

Developed countries $VS_{LT,y}$ values can be used provided the following conditions can be satisfied:
- The genetic source of the production operations livestock originate from an Annex I Party;
- The farm use formulated feed rations (FFR) which are optimized for the various animal(s), stage of growth, category, weight gain/productivity and/or genetics;
- The use of FFR can be validated (through on-farm record keeping, feed supplier, etc.);
- The project specific animal weights are more similar to developed country IPCC default values.

The following sources should be used to calculate baseline emissions:
- IPCC 2006 guidelines, volume 4, chapter 10;
- US-EPA 2001: Development Document for the Proposed Revisions to the National Pollutant Discharge Elimination System Regulation and the Effluent Guidelines for Concentrated Animal Feeding Operations, Chapter 8.2 (http://www.epa.gov/waterscience/guide/cafo/devdoc.html).

The project activity adopted method 3 to calculate $VS_{LT,y}$ based on data availability.

(B) Maximum Methane Production Potential ($B_{0,LT}$):

This value varies by species and diet. Where default values are used, they should be taken from tables 10A-4 through 10A-9 (IPCC 2006 Guidelines for National Greenhouse Gas Inventories volume 4, chapter

10) specific to the country where the project is implemented.

Developed countries $B_{0,LT}$ values can be used provided the following conditions are satisfied:

- The genetic source of the production operations livestock originate from an Annex I Party;
- The farm use formulated feed rations (FFR) which are optimized for the various animal(s), stage of growth, category, weight gain/productivity and/or genetics;
- The use of FFR can be validated (through on-farm record keeping, feed supplier, etc.);
- The project specific animal weights are more similar to developed country IPCC default values.

(C) Methane conversion factors (MCFs):

- The MCF values given in table 10.17, chapter 10, volume 4, IPCC 2006 Guidelines should be used. MCF values depend on the annual average temperature where the anaerobic manure treatment facility in the baseline existed. For average annual temperatures below 10℃ and above 5℃, a linear interpolation should be used to estimate the MCF value at the specific temperature assuming an MCF value of 0 at an annual average of 5℃. Future revisions to the IPCC Guidelines for National Greenhouse Gas Inventories should be taken into account.
- A conservativeness factor should be applied by multiplying MCF values (estimated as per above bullet) with a value of 0.94, to account for the 20% uncertainty in the MCF values as reported by IPCC 2006.

For subsequent treatment stages, the reduction of the volatile solids during a treatment stage is estimated based on referenced data for different treatment types. Emissions from the next treatment stage are then calculated following the approach outlined above, but with volatile solids adjusted for the reduction from the previous treatment stages by multiplying by ($1-R_{VS}$), where R_{VS} is the relative reduction of volatile solids from the previous stage. The relative reduction (R_{VS}) of volatile solids depends on the treatment technology and should be estimated in a conservative manner. Default values for different treatment technologies can be found in table 8-10 of chapter 8.2 in US-EPA (2001)[1].

(ii) N_2O emissions from manure management

$$BE_{N2O,y} = GWP_{N2O} \cdot CF_{N2O-N,N} \cdot \frac{1}{1000} \cdot \left(E_{N2O,y} + E_{N2O,ID,y}\right) \qquad (5)$$

where,

$BE_{N2O,y}$: Annual baseline N_2O emissions in tCO_2e/year.

GWP_{N2O} : Global Warming Potential (GWP) for N_2O.

$CF_{N2O-N,N}$: Conversion factor from N_2O-N to N_2O (44/28).

$E_{N2O,D,y}$: Direct N_2O emission in kg N_2O-N/year.

$E_{N2O,ID,y}$: Indirect N_2O emission in kg N_2O-N/year.

$$E_{N2O,D,y} = \sum_{j,LT} \left(EF_{N2O,D,j} \cdot NEX_{LT,y} \cdot N_{LT} \cdot MS\%_{Blj}\right) \qquad (6)$$

where:

$E_{N2O,D,y}$: Direct nitrous oxide emissions in kg N_2O-N per year.

$EF_{N2O,D,j}$: Direct N_2O emission factor for the treatment system j of the manure management system in kg N_2O-N/kg N (estimated with site-specific, regional or national data if such data is available,

[1] http://www.epa.gov/waterscience/guide/cafo/pdf/DDChapters8.pdf

otherwise use default EF_3 from table 10.21, chapter 10, volume 4, in the IPCC 2006 Guidelines for National Greenhouse Gas Inventories).

$NEX_{LT,y}$: Annual average nitrogen excretion per head of a defined livestock population in kg N/animal/year.

$MS\%_{Bl,j}$: Fraction of manure handled in system j, in %.

N_{LT} : Number of animals of type LT for the year y, expressed in numbers.

$$E_{N2O,ID,y} = \sum_{j,LT} \left(EF_{N2O,ID,j} \cdot F_{gasm} \cdot NEX_{LT,y} \cdot N_{LT} \cdot MS\%_{Bl,j} \right) \tag{7}$$

where:

$E_{N2O,ID,y}$: Indirect nitrous oxide emissions in kg N_2O-N per year.

$EF_{N2O,ID,j}$: Indirect N_2O emission factor for N_2O emissions from atmospheric deposition of nitrogen on soils and water surfaces, kg N_2O-N/kg NH_3-N and NO_x-N emitted, estimated with site-specific, regional or national data if such data is available. Otherwise, default values for EF_4 from table 11.3, chapter 11, volume 4 of IPCC 2006 Guidelines for National Greenhouse Gas Inventories can be used.

$NEX_{LT,y}$: Annual average nitrogen excretion per head of a defined livestock population in kg N/animal/year.

$MS\%_{Bl,j}$: Fraction of manure handled in system j.

F_{gasm} : Percent of managed manure nitrogen for livestock category that volatilises as NH_3 and NO_x in the manure management system.

N_{LT} : Number of animals of type LT for the year y, expressed in numbers.

For subsequent treatment stages, the reduction of the nitrogen during a treatment stage is estimated based on referenced data for different treatment types. Emissions from the next treatment stage are then calculated following the approach outlined above, but with nitrogen adjusted for the reduction from the previous treatment stages by multiplying by (1-R_N), where R_N is the relative reduction of nitrogen from the previous stage. The relative reduction (R_N) of nitrogen depends on the treatment technology and should be estimated in a conservative manner. Default values for different treatment technologies can be found in chapter 8.2 in US-EPA (2001).

Procedure for estimating NEX

$$NEX = N_{intake} * \left(1 - N_{retention}\right) \tag{8}$$

where,

N_{intake} : Annual N intake per animal in kg N/animal/year.

$N_{retention}$: The portion of that N intake that is retained in the animal (default values are reported in table 10.20 in IPCC 2006 guidelines, volume 4, chapter 10).

$$N_{intake} = \left(\frac{GE}{18.45} \right) * \left(\frac{CP/100}{6.25} \right) \tag{9}$$

where,

CP : Crude percent of protein (percent).

GE : Gross energy intake of the animal, in enteric model, based on digestible energy, milk production, pregnancy, current weight, mature weight, rate of weight gain, and IPCC constants, MJ/day.

18.45: Conversion factor for dietary GE per kg of dry matter (MJ/kg). This value is relatively constant across a wide range of forage and grain-based feeds commonly consumed by livestock.

6.25: Conversion factor from kg of dietary protein to kg of dietary N, kg feed protein/kg N.

In absence of availability of project specific information on Protein intake, which should be justified in the CDM-PDD, site-specific national or regional data should be used for the nitrogen excretion NEX, if available. In the absence of such data, default values from table 10.19 of the IPCC 2006 Guidelines, volume 4, chapter 10 may be used and should be corrected for the animal weight at the project site in the following way:

$$NEX_{site} = \frac{W_{site}}{W_{default}} \cdot NEX_{IPCCdefault} \qquad (10)$$

where:

NEX_{site} : Adjusted annual average nitrogen excretion per head of a defined livestock population in kg N/animal/year.

W_{site} : Average animal weight of a defined population at the project site in kg.

$W_{default}$: Default average animal weight of a defined population in kg.

$NEX_{IPCCdefault}$: Default value (IPCC 2006) for the nitrogen excretion per head of a defined livestock population in kg N/animal/year.

$$NEX_{LT} = N_{rate,LT} \cdot \frac{TAM}{1000} \cdot 365 \qquad (11)^{2}$$

where,

NEX_{LT} : Annual Nitrogen excretion for livestock category LT in kg N/animal/year.

$N_{rate,LT}$: Default nitrogen excretion rate in kg N/1000 kg animal mass/day.

TAM : Typical animal mass for livestock category LT in kg.

(2) Project emissions

$$PE_y = PE_{AD,y} + PE_{Aer,y} + PE_{N2O,y} + PE_{PL,y} + PE_{flared,y} + PE_{elec/heat,y} \qquad (12)$$

where:

$PE_{AD,y}$: Leakage from AWMS systems that capture's methane in tCO_2e/year.

$PE_{Aer,y}$: Methane emissions from AWMS that aerobically treats the manure in tCO_2e/year.

$PE_{N2O,y}$: Nitrous oxide emission from project manure waste management system in tCO_2e/year.

$PE_{PL,y}$: Physical leakage of emissions from biogas network to flare the captured methane or supply to the facility where it is used for heat and/or electricity generation in tCO_2e/year.

$PE_{flared,y}$: Project emissions from flaring of the residue gas stream in tCO_2e/year. Because the biogas captured are all used for power generation, these emissions are not accounted for.

$PE_{elec/heat,y}$: Project CO_2 emissions from electricity and/or heat used in the project activity in year y, in tCO_2e/year. Because the biogas collected are used for power generation in the project activity, the electricity generated are much more than the electricity consumed by the manure

[2] Equation 10.30, chapter 10, volume 4, IPCC 2006 Guidelines

management facilities used by the project activity, these emissions are not accounted for.

(i) Methane emissions from AWMS where gas is captured ($PE_{AD,y}$):

IPCC guidelines specify physical leakage from anaerobic digesters as being 15% of total biogas production. Where project participants use lower values for percentage of physical leakage, they should provide measurements proving that this lower value is appropriate for the project.

Ex-ante leakage to be reported in the CDM-PDD will be estimated using equation 13.a or 13.b below, with a leakage factor of 0.15 or a lower value, if properly justified through documented evidence (which should be verified by the DOE).

If project case AWMS is anaerobic digester only, then use equation (13.a), else use equation (13.b).

$$PE_{AD,y} = GWP_{CH4} \cdot D_{CH4} * LF_{AD} * F_{AD} * \sum_{LT} \left(B_{0,LT} * N_{LT} * VS_{LT,y} \right) \quad (13.a)$$

$$PE_{AD,y} = GWP_{CH4} \cdot D_{CH4} * LF_{AD} * F_{AD} * \left[\prod_{n=1}^{N} \left(1 - R_{VS,n} \right) \right] * \sum_{LT} \left(B_{0,LT} * N_{LT} * VS_{LT,y} * MS\%_{j} \right) \quad (13.b)$$

where:

D_{CH4} : CH_4 density (0.00067 t/m^3 at room temperature (20 ºC) and 1 atm pressure).

LF_{AD} : Methane leakage from anaerobic digesters, default of 0.15 multiplied by methane content of biogas.

F_{AD} : Fraction of volatile solid directed to anaerobic digester.

$R_{VS,n}$: Fraction of volatile solid treated in AWMS stage n. The project proponents shall provide the values based on proven test results. In absence of such values the conservative value of volatile solids treated in table 8-10 of chapter 8.2 in US-EPA (2001) shall be used.

LT : Index for livestock type.

$B_{0,LT}$: CH_4 production capacity from manure for livestock type LT, in m^3 CH_4/kg-VS, to be chosen based on procedure provided for in the baseline methodology section.

N_{LT} : Population of livestock type LT for the year y, expressed in numbers.

$VS_{LT,y}$: Annual volatile solid excretion of livestock type LT on a dry-matter basis in kg-dm/animal/year.

$MS\%_j$: Fraction of manure handled in system j.

As noted in equations (13.a) and (13.b), not all volatile solids are degraded in the anaerobic digester. If the undegraded volatile solid in the effluent from anaerobic digester is discharged outside the project boundary without further treatment, these emissions should be treated as leakage and appropriately reported and accounted.

(ii) Methane emissions from aerobic AWMS treatment ($PE_{Aer,y}$):

$$PE_{Aer,y} = GWP_{CH4} \cdot D_{CH4} * 0.001 * F_{Aer} * \left[\prod_{n=1}^{N} \left(1 - R_{VS,n} \right) \right] * \sum_{j,LT} \left(B_{0.LT} * N_{LT} * VS_{LT,y} * MS\%_{j} \right) + PE_{Sl,y} \quad (14)$$

where:

$R_{VS,n}$: Fraction of volatile solid degraded in AWMS treatment method n of the treatment steps prior to waste being treated in aerobic lagoon.

D_{CH4} : CH_4 density (0.00067 t/m^3 at room temperature (20 ºC) and 1 atm pressure).

F_{Aer} : Fraction of volatile solid directed to aerobic system.

LT : Index for livestock type.

$B_{0,LT}$: CH_4 production capacity from manure for livestock type LT, in m^3 CH_4/kg-VS, to be chosen based on procedure provided for in the baseline methodology section.

$VS_{LT,y}$: Annual volatile solid excretion livestock type LT on a dry-matter basis in kg-dm/animal/year.

N_{LT} : Population of livestock type LT for the year y, expressed in numbers.

$PE_{Sl,y}$: CH_4 emissions from sludge disposed of in sludge ponds prior to disposal during the year y, expressed in tCO_2e/year.

$MS\%_j$: Fraction of manure handled in system j.

Aerobic treatment results in large accumulations of sludge. Sludge requires removal and has large VS values. It is important to identify the following management process for the sludge and estimate the emissions from that management process. If the sludge ponds are not within the project boundary, the emissions should be included in leakages. The emissions from sludge ponds shall be estimated as follows:

$$PE_{Sl,y} = GWP_{CH4} \cdot D_{CH4} * MCF_{sl} * F_{Aer} * \left[\prod_{n=1}^{N} \left(1 - R_{VS,n}\right) \right] * \sum_{j,LT} \left(B_{0,LT} * N_{LT} * VS_{LT,y} * MS\%_j \right) \quad (15)$$

where:

$R_{VS,n}$: Fraction of volatile solid degraded in AWMS treatment method *n* of the treatment steps prior to sludge pond.

D_{CH4} : CH_4 density (0.00067 t/m^3 at room temperature (20 ºC) and 1 atm pressure).

F_{Aer} : Fraction of volatile solid directed to Aerobic system.

LT : Index for livestock type.

$B_{0,LT}$: CH_4 production capacity from manure for livestock type LT, in m^3 CH_4/kg-VS, to be chosen based on procedure provided for in the baseline methodology section.

$VS_{LT,y}$: Annual volatile solid excretion of livestock type LT on a dry matter basis in kg-dm/animal/year.

N_{LT} : Population of livestock type LT for the year y, expressed in numbers.

$MS\%_j$: Fraction of manure handled in system j.

MCF_{sl} : Methane conversion factor (MCF) for the sludge stored in sludge ponds estimated as in the baseline emissions section.

(iii) N_2O emissions from manure management ($PE_{N2O,y}$):

$$PE_{N2O,y} = GWP_{N2O} \cdot CF_{N2O-N,N} \cdot \frac{1}{1000} \cdot \left(E_{N2O,D,y} + E_{N2O,ID,y} \right) \quad (16)$$

where,

$PE_{N2O,y}$: Annual project N_2O emissions in tCO_2e/year.

GWP_{N2O} : Global Warming Potential (GWP) for N_2O.

$CF_{N2O-N,N}$: Conversion factor N_2O-N to N_2O (44/28).

$E_{N2O,D,y}$: Direct N_2O emission in kg N_2O-N/year.

$E_{N2O,ID,y}$: Indirect N_2O emission in kg N_2O-N/year.

$$E_{N2O,D,y} = \sum_{j,LT} \left(EF_{N2O,D,j} \cdot NEX_{LT,y} \cdot N_{LT} \cdot MS\%_j \right) \quad (17)$$

where:

$E_{N2O,D,y}$: Direct nitrous oxide emissions in kg N_2O-N/year.

$EF_{N2O,D,j}$: Direct N_2O emission factor for the treatment system j of the manure management system in kg N_2O-N/kg N (estimated with site-specific, regional or national data if such data is available. otherwise use default EF_3 in table 10.21, volume 4, chapter 10, IPCC 2006 Guidelines).

$NEX_{LT,y}$: Annual average nitrogen excretion per head of a defined livestock population in kg N/animal/year.

$MS\%_j$: Fraction of manure handled in system j, in %.

N_{LT} : Population of livestock type LT for the year y, expressed in numbers.

$$E_{N2O,ID,y} = \sum_{j,LT} \left(EF_{N2O,ID,j} * F_{gasm} * NEX_{LT,y} * N_{LT} * MS\%_j \right) \quad (18)$$

where:

$E_{N2O,ID,y}$: Indirect nitrous oxide emissions in kg N_2O-N/year.

$EF_{N2O,ID,j}$: Indirect N_2O emission factor for N_2O emissions from atmospheric deposition of nitrogen on soils and water surfaces, kg N_2O-N/kg NH_3-N and NO_x-N emitted, estimated with site-specific, regional or national data if such data is available. Otherwise, default values for EF_4 from table 11.3, chapter 11, volume 4 of IPCC 2006 guidelines can be used.

$NEX_{LT,y}$: Annual average nitrogen excretion per head of a defined livestock population in kg N/animal/year.

$MS\%_j$: Fraction of manure handled in system j.

F_{gasm} : Percent of managed manure nitrogen for livestock category that volatilises as NH_3 and NO_x in the manure management system.

N_{LT} : Population of livestock type LT for the year y, expressed in numbers.

For subsequent treatment stages, the reduction of the nitrogen during a treatment stage is estimated based on referenced data for different treatment types. Emissions from the next treatment stage are then calculated following the approach outlined above, but with nitrogen adjusted for the reduction from the previous treatment stages by multiplying by (1-R_N), where R_N is the relative reduction of nitrogen from the previous stage. The relative reduction (R_N) of nitrogen depends on the treatment technology and should be estimated in a conservative manner. Default values for different treatment technologies can be found in chapter 8.2 in US-EPA (2001).

The N_2O emissions from sludge ponds shall be estimated as follows:

$$PE_{Sl,N2O,y} = GWP_{N2O} \cdot CF_{N2O-N,N} \cdot \frac{1}{1000} \cdot \left(E_{Sl,N2O,D,y} + E_{Sl,N2O,ID,y} \right) \quad (19)$$

where:

GWP_{N2O} : Global Warming Potential (GWP) for N_2O.

$CF_{N2O-N,N}$: Conversion factor N_2O-N to N_2O (44/28).

$E_{Sl,N2O,D,y}$: Direct N_2O emission from the sludge pond in kg N_2O-N/year.

$E_{Sl,N2O,ID,y}$: Direct N_2O emission from the sludge pond in kg N_2O-N/year.

$$E_{Sl,N2O,y} = \prod_{n=1}^{N} \left(1 - R_{N,n}\right) * \sum_{j,LT} \left(EF_{N2O,D,j} \cdot NEX_{LT,y} \cdot N_{LT} \cdot MS\%_j \right) \quad (20)$$

where:

$E_{Sl,N2O,D,y}$: Direct nitrous oxide emissions from the sludge pond in kg N_2O-N/year.

$R_{N,n}$: Fraction of nitrogen degraded in AWMS treatment method *n* of the treatment steps prior to sludge pond. The relative reduction of nitrogen depends on the treatment technology and should be estimated in a conservative manner. Default values for different treatment technologies can be found in table 8-10 in chapter 8.2 in US-EPA (2001).

$EF_{N2O,D,j}$: Direct N_2O emission factor for the treatment system j of the manure management system in kg N_2O-N/kg N (estimated with site-specific, regional or national data if such data is available. otherwise use default EF_3 in table 10.21, volume 4, chapter 10, IPCC 2006 Guidelines).

$NEX_{LT,y}$: Annual average nitrogen excretion per head of a defined livestock population in kg N/animal/year.

$MS\%_j$: Fraction of manure handled in system j, in %.

N_{LT} : Population of livestock type LT for the year y, expressed in numbers.

$$E_{Sl,N2O,ID,y} = \prod_{n=1}^{N}\left(1 - R_{N,n}\right) * \sum_{j,LT}\left(EF_{N2O,ID,j} \cdot F_{gasm} \cdot \cdot NEX_{LT,y} \cdot N_{LT} \cdot MS\%_j\right) \quad (21)$$

where:

$EF_{N2O,ID,j}$: Indirect nitrous oxide emissions from the sludge pond in kg N_2O N/year.

$R_{N,n}$: Fraction of nitrogen degraded in AWMS treatment method *n* of the treatment steps prior to sludge pond. The relative reduction of nitrogen depends on the treatment technology and should be estimated in a conservative manner. Default values for different treatment technologies can be found in table 8-10 in chapter 8.2 in US-EPA (2001).

$EF_{N2O,ID,j}$: Indirect N_2O emission factor for N_2O emissions from atmospheric deposition of nitrogen on soils and water surfaces, kg N_2O-N/kg NH_3-N and NO_x-N emitted ,estimated with site-specific, regional or national data if such data is available. Otherwise, default values for EF_4 from table 11.3, chapter 11, volume 4 of IPCC 2006 guidelines can be used.

$NEX_{LT,y}$: Annual average nitrogen excretion per head of a defined livestock population in kg N/animal/year.

$MS\%_j$: Fraction of manure handled in system j.

F_{gasm} : Percent of managed manure nitrogen for livestock category that volatilises as NH_3 and NO_x in the manure management system.

N_{LT} : Population of livestock type LT for the year y, expressed in numbers.

(iv) Physical Leakage from distribution network of the captured methane in ($PE_{PL,y}$):

This refers to leaks in the biogas system from the biogas pipeline delivery system. The sum of the quantities of captured methane fed to the flare, to the power plant and to the boiler (measured as per the monitoring plan) must be compared annually with the total methane generated as measured by meter at the outlet of the methane generating digester. The difference between the monitored value of methane generated and that consumed in flare/electricity generation/heat shall be accounted as leakage from the pipelines. In the case where biogas is just flared and the pipeline from collection point to flare is short (i.e., less than 1 km, and for on site delivery only), one flow meter can be used. In such cases the physical leakage may be considered as zero.

The leakage from the pipelines is the difference between the monitored value of methane generated and that consumed in flare/electricity generation/heat which should be calculated based on monitored data, therefore the pipeline leakage would not be estimated ex-ante in the CDM-PDD.

(3) Leakage

Leakage covers the emissions from land application of treated manure, outside the project boundary. Net leakage is the difference between the leakage emissions released in project activity and those released in the baseline scenario. Net leakage is only considered if they are positive.

$$LE_y = \left(LE_{P,N2O} - LE_{B,N2O}\right) + \left(LE_{P,CH4} - LE_{B,CH4}\right) \quad (22)$$

where,

$LE_{P,N2O}$: N_2O emissions released during project activity from land application of the treated manure, in tCO_2e/year.

$LE_{B,N2O}$: N_2O emissions released during baseline scenario from land application of the treated manure, in tCO_2e/year.

$LE_{P,CH4}$: CH_4 emissions released during project activity from land application of the treated manure, in tCO_2e/year.

$LE_{B,CH4}$: CH_4 emissions released during baseline scenario from land application of the treated manure, in tCO_2e/year.

(i) Estimation of N_2O emissions:

The baseline case N_2O emissions are estimated using the following equations:

$$LE_{B,N2O} = GWP_{N2O} \cdot CF_{N2O-N,N} \cdot \frac{1}{1000} * \left(LE_{N2O,land} + LE_{N2O,runoff} + LE_{N2O,vol}\right) \quad (23)$$

$$LE_{N2O,land} = EF_1 * \prod_{n=1}^{N}\left(1 - R_{N,n}\right) * \sum_{LT} NEX_{LT,y} \cdot N_{LT} \quad (24)$$

$$LE_{N2O,runoff} = EF_5 * F_{leach} * \prod_{n=1}^{N}\left(1 - R_{N,n}\right) * \sum_{LT} NEX_{LT,y} \cdot N_{LT} \quad (25)$$

$$LE_{N2O,vol} = EF_4 * \prod_{n=1}^{N}\left(1 - R_{N,n}\right) * F_{gasm} * \sum_{LT} NEX_{LT,y} \cdot N_{LT} \quad (26)$$

where,

$LE_{N2O,land}$: Direct nitrous oxide emission from application of manure waste, in kg N_2O-N/year.

$LE_{N2O,runoff}$: Nitrous oxide emission due to leaching and run-off, in kg N_2O-N/year.

$LE_{N2O,vol}$: Nitrous oxide emissions from atmospheric deposition of N on soils and water surfaces, in kg N_2O-N/year.

F_{gasm} : Fraction of animal manure N that volatizes as NH_3 and NO_x in kg NH_3-N and NO_x-N per kg of N, estimated with site-specific, regional or national data if such data is available. Otherwise, default values from table 11.3, chapter 11, volume 4 of IPCC 2006 guidelines can be used.

N_{LT} : Number of animals of type LT.

NEX_{LT} : Average annual N excretion per head for animal category LT in kg-N/animal/year.

EF_1 : Emission factor for direct emission of N_2O from soils in kg N_2O-N/kg N, estimated with site-specific, regional or national data if such data is available. Otherwise, default values from table 11.1, chapter 11, volume 4 of IPCC 2006 guidelines can be used.

EF_5 : Emission factor for indirect emission of N_2O from runoff in kg N_2O-N/kg N, estimated with site-specific, regional or national data if such data is available. Otherwise, default values from table 11.3, chapter 11, volume 4 of IPCC 2006 guidelines can be used.

EF_4 : Emission factor for N_2O emissions from atmospheric deposition of N on soils and water surfaces, [kg N-N_2O / (kg NH_3-N+NO_x-N volatilized)], estimated with site-specific, regional or national data if such data is available. Otherwise, default values from table 11.3, chapter 11, volume 4 of IPCC 2006 guidelines can be used.

F_{leach} : Fraction of all N added to/mineralised in managed soils in regions where leaching/runoff occurs that is lost through leaching and runoff should be estimated with site-specific, regional or national data if such data is available. Otherwise, default values from table 11.3, chapter 11, volume 4 of IPCC 2006 guidelines can be used.

$CF_{N2O-N,N}$: Conversion factor (= 44/28).

$R_{N,n}$: Fraction of NEX in manure waste that is reduced in the baseline AWMS. The relative reduction of nitrogen depends on the treatment technology and should be estimated in a conservative manner. Default values for different treatment technologies can be found in table 8-10 in chapter 8.2 in US-EPA (2001).

The project case N_2O emissions are estimated using the following equations:

$$LE_{P,N2O} = GWP_{N2O} \cdot CF_{N2O-N,N} \cdot \frac{1}{1000} * \left(LE_{N2O,land} + LE_{N2O,runoff} + LE_{N2O,vol}\right) \quad (27)$$

$$LE_{N2O,land} = EF_1 * \prod_{n=1}^{N}\left(1 - R_{N,n}\right) * \sum_{LT} NEX_{LT,y} \cdot N_{LT} \quad (28)$$

$$LE_{N2O,runoff} = EF_5 * F_{leach} * \prod_{n=1}^{N}\left(1 - R_{N,n}\right) * \sum_{LT} NEX_{LT,y} \cdot N_{LT} \quad (29)$$

$$LE_{N2O,vol} = EF_4 * \prod_{n=1}^{N}\left(1 - R_{N,n}\right) * F_{gasm} * \sum_{LT} NEX_{LT,y} \cdot N_{LT} \quad (30)$$

where,

$LE_{N2O,land}$: Direct nitrous oxide emission from application of manure waste, in kg N_2O-N/year.

$LE_{N2O,runoff}$: Nitrous oxide emission due to leaching and run-off, in kg N_2O-N/year.

$LE_{N2O,vol}$: Nitrous oxide emissions from atmospheric deposition of N on soils and water surfaces, in kg N_2O-N/year.

F_{gasm} : Fraction of animal manure N that volatizes as NH_3 and NO_x in kg NH_3-N and NO_x-N per kg of N, estimated with site-specific, regional or national data if such data is available. Otherwise, default values from table 11.3, chapter 11, volume 4 of IPCC 2006 guidelines can be used.

N_{LT}: Number of animals of type LT.

NEX_{LT} : Average annual N excretion per head for animal category LT in kg N/animal/year.

EF_1 : Emission factor for direct emission of N_2O from soils in kg N_2O-N/kg N, estimated with site-specific, regional or national data if such data is available. Otherwise, default values from table 11.1, chapter 11, volume 4 of IPCC 2006 guidelines can be used.

EF_5 : Emission factor for indirect emission of N_2O from runoff in kg N_2O-N/kg N, estimated with site-specific, regional or national data if such data is available. Otherwise, default values from table 11.3, chapter 11, volume 4 of IPCC 2006 guidelines can be used.

EF_4 : Emission factor for N_2O emissions from atmospheric deposition of N on soils and water surfaces, [kg N-N_2O / (kg NH_3-N+NO_x-N volatilized)], estimated with site-specific, regional or national data if such data is available. Otherwise, default values from table 11.3, chapter 11, volume 4 of IPCC

2006 guidelines can be used.

F_{leach} : Fraction of all N added to/mineralised in managed soils in regions where leaching/runoff occurs that is lost through leaching and runoff should be estimated with site-specific, regional or national data if such data is available. Otherwise, default values from table 11.3, chapter 11, volume 4 of IPCC 2006 guidelines can be used.

$CF_{N2O-N,N}$: Conversion factor (= 44/28).

$R_{N,n}$: Fraction of NEX in manure waste that is reduced in the project AWMS. The relative reduction of nitrogen depends on the treatment technology and should be estimated in a conservative manner. Default values for different treatment technologies can be found in table 8-10 in chapter 8.2 in US-EPA (2001).

It is possible to measure the quantity of manure applied to land in kg manure/year (Q_{DM}) and the nitrogen concentration in kg N/kg manure (N_{DM}) in the manure to estimate the total quantity of nitrogen applied to land. In this case, $\prod_{n=1}^{N}\left(1-R_{N,n}\right)*\sum_{LT} NEX_{LT,y}\cdot N_{LT}$ in equations (28), (29) and (30) above should be substituted by $Q_{DM} * N_{DM}$.

(ii) Methane emissions from disposal of treated manure

The calculation of methane emissions from land application of manure in the baseline and project cases are estimated from equations (31) and (32) below:

$$LE_{B,CH4} = GWP_{CH4} * D_{CH4} * MCF_d * \left[\prod_{n=1}^{N}\left(1-R_{VS,n}\right)\right] * \sum_{j,LT}\left(B_{0,LT} * N_{LT} * VS_{LT,y} * MS\%_j\right) \quad (31)$$

$$LE_{P,CH4} = GWP_{CH4} * D_{CH4} * MCF_d * \left[\prod_{n=1}^{N}\left(1-R_{VS,n}\right)\right] * \sum_{j,LT}\left(B_{0,LT} * N_{LT} * VS_{LT,y} * MS\%_j\right) \quad (32)$$

where,

$LE_{B,CH4}$: Methane leakage emissions in the baseline (tCO_2e/year).

$LE_{P,CH4}$: Methane leakage emissions in the project case (tCO_2e/year)

$R_{VS,n}$: Fraction of volatile solid degraded in AWMS n prior to sludge being treated. Values for R_{VS} should be taken from table 8-10 in chapter 8.2 in US-EPA (2001).

GWP_{CH4} : Global Warming Potential (GWP) of CH_4.

D_{CH4} : CH_4 density (0.00067 t/m^3 at room temperature (20 ºC) and 1 atm pressure).

$B_{0,LT}$: Maximum methane producing potential of the volatile solid generated, in m^3 CH_4/kg-dm, by animal type LT.

N_{LT} : Number of animals of type LT for the year y, expressed in numbers.

$VS_{LT,y}$: Annual volatile solids from livestock LT, on a dry matter weight basis (kg-dm/year).

$MS\%_j$: Fraction of manure handled in system j.

MCF_d : Methane conversion factor (MCF) assumed to be equal to 1.

(4) Emission reductions

The emission reduction ER_y by the project activity during a given year y is the difference between the baseline emissions (BE_y) and the sum of project emissions (PE_y) and leakage, as follows:

$$ER_y = BE_y - PE_y - LE_y \quad (33)$$

Further, in estimating emissions reduction for claiming certified emissions reductions, if the calculated CH_4 baseline emissions from anaerobic lagoons are higher than the measured CH_4 generated in the anaerobic digester in the project situation (this is calculated as product of biogas flow at the digester outlet and methane fraction in the biogas), then the latter shall be used to calculate the emissions reduction for claiming certified emissions reductions. Therefore, the actual methane captured from an anaerobic digester shall be compared to the ($BE_{CH4,y}$-$PE_{AD,y}$-$PE_{PL,y}$) and if found lower, then ($BE_{CH4,y}$-$PE_{AD,y}$-$PE_{PL,y}$) (which is a component of BE_y-PE_y) in equation (33) is replaced by actual methane captured.

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

>>

Data / Parameter:	$R_{VS,n}$
Data unit:	Fraction
Description:	VS degradation factor
Source of data used:	US-EPA 2001: Development Document for the Proposed Revisions to the National Pollutant Discharge Elimination System Regulation and the Effluent Guidelines for Concentrated Animal Feeding Operations, chapter 8.2
Value applied:	Uncovered anaerobic lagoon: 75% Anaerobic digester: 80% Aerobic treatment: 20%
Justification of the choice of data or description of measurement methods and procedures actually applied :	Recommended by the methodology. Archive electronically during project plus 5 years.
Any comment:	The most conservative value for the given technology must be used.

Data / Parameter:	$EF_{N2O,D,y}$
Data unit:	kg N_2O-N/kg N
Description:	Direct N_2O emission factors
Source of data used:	Default EF_3 in table 10.21, chapter 10, volume 4, IPCC 2006 Guidelines
Value applied:	Uncovered anaerobic lagoon: 0 Aerobic treatment: 0.005 Sludge pond: 0.006
Justification of the choice of data or description of measurement methods and procedures actually applied :	Recommended by the methodology. Archive electronically during project plus 5 years.
Any comment:	Country specific or region specific data are not available, so IPCC 2006 default values are used.

Data / Parameter:	$EF_{N2O,ID,y}$
Data unit:	kg N_2O-N/kg NH_3-N and NO_x-N
Description:	Indirect N_2O emission factors used
Source of data used:	Default EF_4 in table 11.3, chapter 11, volume 4, IPCC 2006 Guidelines

Value applied:	0.010
Justification of the choice of data or description of measurement methods and procedures actually applied :	Recommended by the methodology. Archive electronically during project plus 5 years.
Any comment:	Country specific or region specific data are not available, so IPCC 2006 default values are used.

Data / Parameter:	F_{gasm}
Data unit:	Fraction
Description:	Fraction of N lost due to volatilization
Source of data used:	Table 11.3, chapter 11, volume 4, IPCC 2006 Guidelines
Value applied:	0.20
Justification of the choice of data or description of measurement methods and procedures actually applied :	Recommended by the methodology. Archive electronically during project plus 5 years.
Any comment:	Country specific or region specific data are not available, so IPCC 2006 default values are used.

Data / Parameter:	EF_1
Data unit:	kg N_2O-N/kg N
Description:	Emission factor for direct emissions of N_2O from soils
Source of data used:	Table 11.1, chapter 11, volume 4, IPCC 2006 Guidelines
Value applied:	0.01
Justification of the choice of data or description of measurement methods and procedures actually applied :	Recommended by the methodology. Archive electronically during project plus 5 years.
Any comment:	Country specific or region specific data are not available, so IPCC 2006 default values are used.

Data / Parameter:	EF_4
Data unit:	kg N_2O-N/kg NH_3-N and NO_x-N
Description:	Emission factor for N_2O emission from atmospheric deposition of N on soils and water surfaces
Source of data used:	Table 11.3, chapter 11, volume 4, IPCC 2006 Guidelines
Value applied:	0.010
Justification of the choice of data or description of measurement methods	Recommended by the methodology. Archive electronically during project plus 5 years.

and procedures actually applied :	
Any comment:	Country specific or region specific data are not available, so IPCC 2006 default values are used.

Data / Parameter:	EF_5
Data unit:	kg N_2O-N/kg N
Description:	Emission factor for indirect emission of N_2O from runoff
Source of data used:	Table 11.3, chapter 11, volume 4, IPCC 2006 Guidelines
Value applied:	0.0075
Justification of the choice of data or description of measurement methods and procedures actually applied :	Recommended by the methodology. Archive electronically during project plus 5 years.
Any comment:	Country specific or region specific data are not available, so IPCC 2006 default values are used.

Data / Parameter:	F_{leach}
Data unit:	Fraction
Description:	Fraction of N leached
Source of data used:	Table 11.3, chapter 11, volume 4, IPCC 2006 Guidelines
Value applied:	0.30
Justification of the choice of data or description of measurement methods and procedures actually applied :	Recommended by the methodology. Archive electronically during project plus 5 years.
Any comment:	Country specific or region specific data are not available, so IPCC 2006 default values are used.

Data / Parameter:	nd_y
Data unit:	Number
Description:	Number of days treatment plant was operational in year y
Source of data used:	Project proponents
Value applied:	365
Justification of the choice of data or description of measurement methods and procedures actually applied :	Archive electronically during project plus 5 years.
Any comment:	---

Data / Parameter:	$MS\%_{Bl,\ j}$
Data unit:	Fraction

Description:	Fraction of manure handled in system j in the baseline
Source of data used:	Project proponents
Value applied:	100%
Justification of the choice of data or description of measurement methods and procedures actually applied :	Archive electronically during project plus 5 years.
Any comment:	---

Data / Parameter:	GWP_{CH4}
Data unit:	tCO_2e/tCH_4
Description:	Global warming potential for CH_4
Source of data used:	IPCC
Value applied:	21
Justification of the choice of data or description of measurement methods and procedures actually applied :	21 for the first commitment period. Shall be updated according to any future COP/MOP decisions.
Any comment:	---

Data / Parameter:	GWP_{N2O}
Data unit:	tCO_2e/tN_2O
Description:	Global warming potential for N_2O
Source of data used:	IPCC
Value applied:	310
Justification of the choice of data or description of measurement methods and procedures actually applied :	310 for the first commitment period. Shall be updated according to any future COP/MOP decisions.
Any comment:	---

Data / Parameter:	D_{CH4}
Data unit:	t/m^3
Description:	Density of methane
Source of data used:	Technical literature
Value applied:	0.00067
Justification of the choice of data or description of measurement methods and procedures actually applied :	Recommended by the methodology. Archive electronically during project plus 5 years.

Any comment:	0.00067 t/m^3 at room temperature 20℃ and 1 atm pressure.

Data / Parameter:	MCF_d
Data unit:	Fraction
Description:	Methane conversion factor for leakage calculation assumed to be equal 1
Source of data used:	See Leakage section
Value applied:	1
Justification of the choice of data or description of measurement methods and procedures actually applied :	Recommended by the methodology. Archive electronically during project plus 5 years.
Any comment:	---

Data / Parameter:	$CF_{N2O\text{-}N,\ N2O}$
Data unit:	---
Description:	Conversion factor from N_2O-N to N_2O
Source of data used:	Technical literature
Value applied:	44/28
Justification of the choice of data or description of measurement methods and procedures actually applied :	Recommended by the methodology. Archive electronically during project plus 5 years.
Any comment:	---

B.6.3 Ex-ante calculation of emission reductions:

>>

Baseline emissions:

$$BE_{CH4,y} = GWP_{CH4} \cdot D_{CH4} * \sum_{j,LT} MCF_j * B_{0,LT} * N_{LT} * VS_{LT,y} * MS\%_{Bl,j}$$

$$= 21 * 0.00067 * 74\% * 0.94 * 0.29 * 188500 * \frac{69.6}{28} * 0.3 * 365 * 100\%$$

$$= 145622\ tCO_2e / year$$

$$BE_{N2O,y} = GWP_{N2O} \cdot CF_{N2O-N,N} \cdot \frac{1}{1000} \cdot \left[\begin{array}{l} \sum_{j,LT} \left(EF_{N2O,D,j} \cdot NEX_{LT,y} \cdot N_{LT} \cdot MS\%_{Bl,j} \right) \\ + \sum_{j,LT} \left(EF_{N2O,ID,j} \cdot F_{gasm} \cdot NEX_{LT,y} \cdot N_{LT} \cdot MS\%_{Bl,j} \right) \end{array} \right]$$

$$= 310 * \frac{44}{28} * \frac{1}{1000} * \left(0 + 0.01 * 0.2 * 0.5 * \frac{69.6}{1000} * 365 * 188500 * 100\% \right)$$

$$= 2333\ tCO_2e / year$$

$$BE_y = BE_{CH4,y} + BE_{N2O,y} = 145622\ tCO_2e/year + 2333\ tCO_2e/year = 147955\ tCO_2e/year$$

Project emissions:

$$PE_{AD,y} = GWP_{CH4} \cdot D_{CH4} * LF_{AD} * F_{AD} * \sum_{LT} \left(B_{0,LT} * N_{LT} * VS_{LT,y} \right)$$
$$= 21 * 0.00067 * 0.15 * 70\% * 90\% * 0.29 * 188500 * \frac{69.6}{28} * 0.3 * 365 * 100\%$$
$$= 19783\ tCO_2e/year$$

$$PE_{Aer,y} = GWP_{CH4} \cdot D_{CH4} * 0.001 * F_{Aer} * \left[\prod_{n=1}^{N} \left(1 - R_{VS,n}\right) \right] * \sum_{j,LT} \left(B_{o,LT} * N_{LT} * VS_{LT,y} * MS\%_j \right)$$
$$+ GWP_{CH4} \cdot D_{CH4} * MCF_{sl} * F_{Aer} * \left[\prod_{n=1}^{N} \left(1 - R_{VS,n}\right) \right] * \sum_{j,LT} \left(B_{o,LT} * N_{LT} * VS_{LT,y} * MS\%_j \right)$$
$$= 21 * 0.00067 * 0.001 * 90\% * \left(1 - 80\%\right) * 0.29 * 188500 * \frac{69.6}{28} * 0.3 * 365 * 100\%$$
$$+ 21 * 0.00067 * 0.5\% * 94\% * 90\% * \left(1 - 80\%\right) * 0.29 * 188500 * \frac{69.6}{28} * 0.3 * 365 * 100\%$$
$$= 38\ tCO_2e/year + 177\ tCO_2e/year = 215\ tCO_2e/year$$

$$PE_{N2O,y} = GWP_{N2O} \cdot CF_{N2O-N,N} \cdot \frac{1}{1000} \cdot \left[\begin{array}{l} \sum_{j,LT} \left(EF_{N2O,D,j} \cdot NEX_{LT,y} \cdot N_{LT} \cdot MS\%_j \right) \\ + \sum_{j,LT} \left(EF_{N2O,ID,y} \cdot F_{gasm} \cdot NEX_{LT,y} \cdot N_{LT} \cdot MS\%_j \right) \end{array} \right]$$
$$+ GWP_{N2O} \cdot CF_{N2O-N,N} \cdot \frac{1}{1000} \cdot \left[\begin{array}{l} \prod_{n=1}^{N} \left(1 - R_{N,n}\right) * \sum_{j,LT} \left(EF_{N2O,D,j} \cdot NEX_{LT,y} \cdot N_{LT} \cdot MS\%_j \right) \\ + \prod_{n=1}^{N} \left(1 - R_{N,n}\right) * \sum_{j,LT} \left(EF_{N2O,ID,y} \cdot F_{gasm} \cdot NEX_{LT,y} \cdot N_{LT} \cdot MS\%_j \right) \end{array} \right]$$
$$= 310 * \frac{44}{28} * \frac{1}{1000} * \left(\begin{array}{l} 0.005 * 0.5 * \frac{69.6}{1000} * 365 * 188500 * 100\% \\ + 0.01 * 0.2 * 0.5 * \frac{69.6}{1000} * 365 * 188500 * 100\% \end{array} \right)$$
$$+ 310 * \frac{44}{28} * \frac{1}{1000} * \left[\begin{array}{l} \left(1 - 0\right) * 0.006 * 0.5 * \frac{69.6}{1000} * 365 * 188500 * 100\% \\ + \left(1 - 0\right) * 0.01 * 0.2 * 0.5 * \frac{69.6}{1000} * 365 * 188500 * 10 \end{array} \right]$$
$$= 8165\ tCO_2e/year + 9331\ tCO_2e/year = 17496\ tCO_2e/year$$

$$PE_y = PE_{AD,y} + PE_{Aer,y} + PE_{N2O,y} + PE_{PL,y}$$
$$= 19783\ tCO_2e/year + 215\ tCO_2e/year + 17496\ tCO_2e/year = 37494\ tCO_2e/year$$

Leakage:

$$LE_{B,N2O} = GWP_{N2O} \cdot CF_{N2O-N,N} \cdot \frac{1}{1000} * \left(LE_{N2O,land} + LE_{N2O,runoff} + LE_{N2O,vol}\right)$$

$$= GWP_{N2O} \cdot CF_{N2O-N,N} \cdot \frac{1}{1000} * \begin{bmatrix} EF_1 * \prod_{n=1}^{N}\left(1-R_{N,n}\right) * \sum_{LT} NEX_{LT,y} \cdot N_{LT} \\ + EF_5 * F_{leach} * \prod_{n=1}^{N}\left(1-R_{N,n}\right) * \sum_{LT} NEX_{LT,y} \cdot N_{LT} \\ + EF_4 * \prod_{n=1}^{N}\left(1-R_{N,n}\right) * F_{gasm} * \sum_{LT} NEX_{LT,y} \cdot N_{LT} \end{bmatrix}$$

$$= 310 * \frac{44}{28} * \frac{1}{1000} * \begin{bmatrix} 0.01 * (1-60\%) * 0.5 * \frac{69.6}{1000} * 365 * 188500 \\ + 0.0075 * 0.3 * (1-60\%) * 0.5 * \frac{69.6}{1000} * 365 * 188500 \\ + 0.01 * (1-60\%) * 0.2 * 0.5 * \frac{69.6}{1000} * 365 * 188500 \end{bmatrix}$$

$$= 6648\, tCO_2e / year$$

$$LE_{P,N2O} = GWP_{N2O} \cdot CF_{N2O-N,N} \cdot \frac{1}{1000} * \left(LE_{N2O,land} + LE_{N2O,runoff} + LE_{N2O,vol}\right)$$

$$= GWP_{N2O} \cdot CF_{N2O-N,N} \cdot \frac{1}{1000} * \begin{bmatrix} EF_1 * \prod_{n=1}^{N}\left(1-R_{N,n}\right) * \sum_{LT} NEX_{LT,y} \cdot N_{LT} \\ + EF_5 * F_{leach} * \prod_{n=1}^{N}\left(1-R_{N,n}\right) * \sum_{LT} NEX_{LT,y} \cdot N_{LT} \\ + EF_4 * \prod_{n=1}^{N}\left(1-R_{N,n}\right) * F_{gasm} * \sum_{LT} NEX_{LT,y} \cdot N_{LT} \end{bmatrix}$$

$$= 310 * \frac{44}{28} * \frac{1}{1000} * \begin{bmatrix} 0.01 * (1-70\%) * 0.5 * \frac{69.6}{1000} * 365 * 188500 \\ + 0.0075 * 0.3 * (1-70\%) * 0.5 * \frac{69.6}{1000} * 365 * 188500 \\ + 0.01 * (1-70\%) * 0.2 * 0.5 * \frac{69.6}{1000} * 365 * 188500 \end{bmatrix}$$

$$= 4986\, tCO_2e / year$$

$$LE_{B,CH4} = GWP_{CH4} * D_{CH4} * MCF_d * \left[\prod_{n=1}^{N}\left(1 - R_{VS,n}\right)\right] * \sum_{j,LT}\left(B_{0,LT} * N_{LT} * VS_{LT,y} * MS\%_j\right)$$
$$= 21 * 0.00067 * 1 * \left(1 - 75\%\right) * 0.29 * 188500 * \frac{69.6}{28} * 0.3 * 365 * 100\%$$
$$= 52337\ tCO_2e / year$$

$$LE_{P,CH4} = GWP_{CH4} * D_{CH4} * MCF_d * \left[\prod_{n=1}^{N}\left(1 - R_{VS,n}\right)\right] * \sum_{j,LT}\left(B_{0,LT} * N_{LT} * VS_{LT,y} * MS\%_j\right)$$
$$= 21 * 0.00067 * 1 * \left(1 - 80\%\right) * \left(1 - 20\%\right) * 0.29 * 188500 * \frac{69.6}{28} * 0.3 * 365 * 100\%$$
$$= 33496\ tCO_2e / year$$

$$LE_y = \left(LE_{P,N2O} - LE_{B,N2O}\right) + \left(LE_{P,CH4} - LE_{B,CH4}\right)$$
$$= \left(4986 - 6648\right) + \left(33496 - 52337\right) = -20503\ tCO_2e / year$$

According to methodology ACM0010, the leakage covers the emissions from land application of treated manure, outside the project boundary. Net leakage is the difference between the leakage emissions released in project activity and those released in the baseline scenario. Net leakage is only considered if they are positive, so it is not considered in this project.

Emission reductions:

$$ER_y = BE_y - PE_y - LE_y = 147955 - 37494 - 0 = 110461\ tCO_2e / year$$

The annual emissions of the project activity are 37,494 tCO_2e and the annual baseline emissions are 147,955 tCO_2e, so the annual emission reductions of the project activity are 110,461 tCO_2e.

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

>> The following table summaries the results of the ex-ante estimation of emission reductions:

Year	Estimation of project activity emissions (tonnes of CO_2e)	Estimation of baseline emissions (tonnes of CO_2e)	Estimation of leakage (tonnes of CO_2e)	Estimation of overall emission reductions (tonnes of CO_2e)
2007.4.1～2007.12.31	28,120	110,966	0	82,846
2008	37,494	147,955	0	110,461
2009	37,494	147,955	0	110,461
2010	37,494	147,955	0	110,461
2011	37,494	147,955	0	110,461
2012	37,494	147,955	0	110,461
2013	37,494	147,955	0	110,461
2014	37,494	147,955	0	110,461

2015	37,494	147,955	0	110,461
2016	37,494	147,955	0	110,461
2017.1.1～ 2017.3.31	9,374	36,989	0	27,615
Total (tonnes of CO_2e)	**374,940**	**1,479,550**	**0**	**1,104,610**

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

B.7.1 Data and parameters monitored:

Data / Parameter:	MCF
Data unit:	Fraction
Description:	Methane conversion factor
Source of data to be used:	Table 10.17, chapter 10, volume 4, IPCC 2006 Guidelines
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Uncovered anaerobic lagoon: 74%×0.94
Description of measurement methods and procedures to be applied:	Monitored annually. Archive electronically during project plus 5 years.
QA/QC procedures to be applied:	---
Any comment:	No country or regional specific value is available. The factor MCF is taken from IPCC 2006 guidelines. If annual average temperature is lower than 10℃ and higher than 5℃, annual MCF should be estimated using linear interpolation assuming MCF=0 at annual average temperature of 5℃.

Data / Parameter:	MCF_{sl}
Data unit:	Fraction
Description:	Methane conversion factor for the sludge stored in sludge pond
Source of data to be used:	Table 10.17, chapter 10, volume 4, IPCC 2006 Guidelines
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0.5%×0.94
Description of measurement methods and procedures to be applied:	Monitored annually. Archive electronically during project plus 5 years.
QA/QC procedures to	---

be applied:	
Any comment:	No country or regional specific value is available. The factor MCF is taken from IPCC 2006 guidelines. If annual average temperature is lower than 10℃ and higher than 5℃, annual MCF should be estimated using linear interpolation assuming MCF=0 at annual average temperature of 5℃.

Data / Parameter:	$B_{0,LT}$
Data unit:	m^3 CH_4/kg-VS
Description:	Maximum methane production
Source of data to be used:	Table 10A-7 and 10A-8, chapter 10, volume 4, IPCC 2006 Guidelines
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0.29
Description of measurement methods and procedures to be applied:	Monitored annually. Archive electronically during project plus 5 years.
QA/QC procedures to be applied:	---
Any comment:	The parameter value should be updated on future revisions to the IPCC Guidelines for National Greenhouse Gas Inventories.

Data / Parameter:	$VS_{default}$
Data unit:	kg-dm/animal/day
Description:	Default value for the volatile solid excretion per day per animal on a dry matter basis for a defined swine population
Source of data to be used:	Table 10A-7 and 10A-8, chapter 10, volume 4, IPCC 2006 Guidelines
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0.3
Description of measurement methods and procedures to be applied:	Monitored annually. Archive electronically during project plus 5 years.
QA/QC procedures to be applied:	---
Any comment:	The parameter value should be updated on future revisions to the IPCC Guidelines for National Greenhouse Gas Inventories.

Data / Parameter:	$W_{default}$
Data unit:	kg
Description:	Default average swine weight of a defined swine population

Source of data to be used:	Table 10A-7 and 10A-8, chapter 10, volume 4, IPCC 2006 Guidelines
Value of data applied for the purpose of calculating expected emission reductions in section B.5	28
Description of measurement methods and procedures to be applied:	Monitored annually. Archive electronically during project plus 5 years.
QA/QC procedures to be applied:	---
Any comment:	The parameter value should be updated on future revisions to the IPCC Guidelines for National Greenhouse Gas Inventories.

Data / Parameter:	LF_{AD}
Data unit:	Fraction
Description:	Fraction of methane leakage from anaerobic digester
Source of data to be used:	IPCC 2006 Guidelines
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0.15×70%
Description of measurement methods and procedures to be applied:	The biogas leakage given by IPCC default is multiplied by methane content of biogas that is 60%. Monitored annually. Archive electronically during project plus 5 years.
QA/QC procedures to be applied:	
Any comment:	IPCC default of 0.15 or less if documented evidence can be provided (to be checked by DOE).

Data / Parameter:	$R_{N,n}$
Data unit:	Fraction
Description:	Nitrogen degradation factor
Source of data to be used:	Table 8-10, chapter8.2, US-EPA(2001)
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Uncovered anaerobic lagoon: 60% Anaerobic digester: 0 Aerobic treatment: 70%
Description of measurement methods and procedures to be applied:	Monitored annually. Archive electronically during project plus 5 years.

QA/QC procedures to be applied:	---
Any comment:	The most conservative value for the given technology must be used.

Data / Parameter:	Type
Data unit:	---
Description:	Type of swine barn and AWMS
Source of data to be used:	Project proponents
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Not needed
Description of measurement methods and procedures to be applied:	The swine barn and AWMS layout and configuration are collected. Archive electronically during project plus 5 years.
QA/QC procedures to be applied:	---
Any comment:	Swine barn and AWMS layout and configuration.

Data / Parameter:	T
Data unit:	℃
Description:	Annual Average ambient temperature at project site
Source of data to be used:	Project proponents
Value of data applied for the purpose of calculating expected emission reductions in section B.5	15.3
Description of measurement methods and procedures to be applied:	Monitored monthly. Archive electronically during project plus 5 years.
QA/QC procedures to be applied:	---
Any comment:	Used to select the annual MCF from IPCC 2006 guidelines.

Data / Parameter:	$EG_{d,y}$
Data unit:	MWh
Description:	Electricity generation
Source of data to be used:	Project proponents
Value of data applied for the purpose of calculating expected	Not needed

emission reductions in section B.5	
Description of measurement methods and procedures to be applied:	Monitored annually. Archive electronically during project plus 5 years.
QA/QC procedures to be applied:	Electricity meters will undergo maintenance/calibration subject to appropriate industry standards. Uncertainty of the meters to be obtained from the manufacturers.
Any comment:	Electricity will be used by the company, other than delivered to the grid.

Data / Parameter:	Regulations
Data unit:	---
Description:	Existence and enforcement of relevant regulation
Source of data to be used:	Project proponents
Value of data applied for the purpose of calculating expected emission reductions in section B.5	---
Description of measurement methods and procedures to be applied:	Monitored at start of crediting period.
QA/QC procedures to be applied:	Quality control for the existence and enforcement of relevant regulations and incentives is beyond the bounds of the project activity. Instead, the DOE will verify the evidence collected.
Any comment:	---

Data / Parameter:	N_{LT}
Data unit:	Number
Description:	Average swine population used in both baseline and project case emissions estimation.
Source of data to be used:	Project proponents
Value of data applied for the purpose of calculating expected emission reductions in section B.5	188,850
Description of measurement methods and procedures to be applied:	To be collected for each swine population in all of the pig barns. Animal stock and inlet program of pigs (Net inlet considering mortality) are recorded. Monitored monthly. Archive electronically during project plus 5 years.
QA/QC procedures to be applied:	---
Any comment:	The consistency between the value and indirect information (records of sales, records of food purchases) should be assessed.

Data / Parameter:	W_{site}
Data unit:	kg
Description:	Weight of swine
Source of data to be used:	Project proponents
Value of data applied for the purpose of calculating expected emission reductions in section B.5	69.6
Description of measurement methods and procedures to be applied:	Average weight of each species and age class. Monitored monthly. Archive electronically during project plus 5 years.
QA/QC procedures to be applied:	---
Any comment:	

Data / Parameter:	F_{AD}
Data unit:	Fraction
Description:	Fraction of volatile solids directed to anaerobic digesters
Source of data to be used:	Project proponents
Value of data applied for the purpose of calculating expected emission reductions in section B.5	90%
Description of measurement methods and procedures to be applied:	Monitored monthly. Archive electronically during project plus 5 years.
QA/QC procedures to be applied:	---
Any comment:	The VS reduction in the solid separation process is 10%.

Data / Parameter:	F_{Aer}
Data unit:	Fraction
Description:	Fraction of volatile solids directed to aerobic treatment
Source of data to be used:	Project proponents
Value of data applied for the purpose of calculating expected emission reductions in section B.5	90%
Description of measurement methods	Monitored monthly. Archive electronically during project plus 5 years.

and procedures to be applied:	
QA/QC procedures to be applied:	---
Any comment:	The VS reduction in the solid separation process is 10%.

Data / Parameter:	V_f
Data unit:	m^3
Description:	Biogas flow
Source of data to be used:	Project proponents
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Not needed
Description of measurement methods and procedures to be applied:	Measured continuously by two flow meters, one is installed at the outlet of the anaerobic digester and the other one is installed at the inlet of the gas chamber. Reported cumulatively on weekly basis. Archive electronically during project plus 5 years.
QA/QC procedures to be applied:	Flow meters will undergo maintenance/calibration subject to appropriate industry standards.
Any comment:	The biogas generated in the project activity is supplied to the generator through gas chamber and the pipeline from the gas chamber to the generator is too short, so only two flow meters are installed.

Data / Parameter:	C_{CH4}
Data unit:	Fraction
Description:	Methane fraction of biogas
Source of data to be used:	Project proponents
Value of data applied for the purpose of calculating expected emission reductions in section B.5	70%
Description of measurement methods and procedures to be applied:	Methane content will be measured continuously with a fixed gas analyser by the project proponents. Reported monthly. Archive electronically during project plus 5 years. Shall be measured on wet basis.
QA/QC procedures to be applied:	The gas analyser should be subject to a regular maintenance and testing regime to ensure accuracy.
Any comment:	

Data / Parameter:	$MS\%_j$
Data unit:	Fraction
Description:	Fraction of manure handled in system j in project activity
Source of data to be	Project proponents

used:	
Value of data applied for the purpose of calculating expected emission reductions in section B.5	100%
Description of measurement methods and procedures to be applied:	Monitored annually. Archive electronically during project plus 5 years.
QA/QC procedures to be applied:	---
Any comment:	---

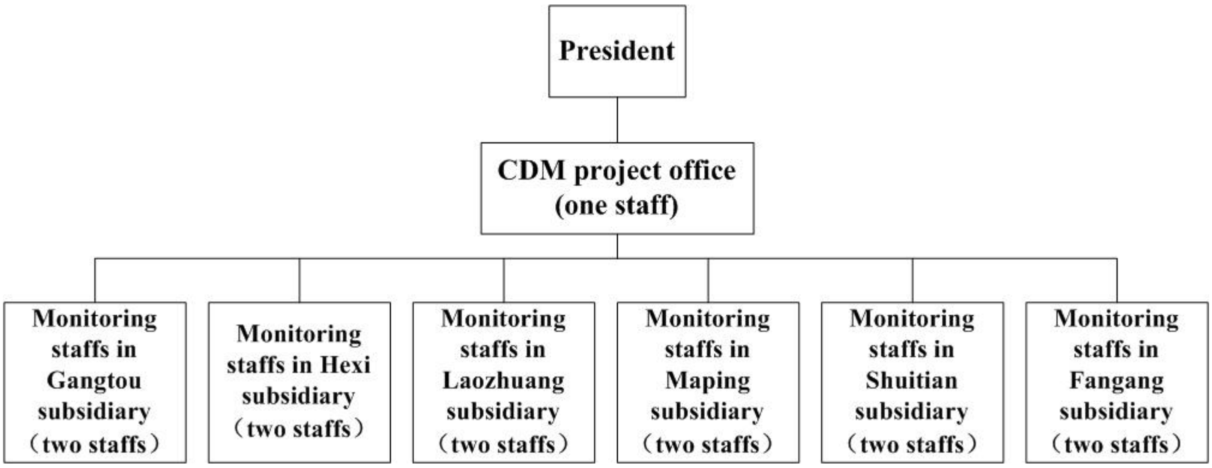
Data / Parameter:	$N_{rate,LT}$
Data unit:	kg N/1000kg mass/day
Description:	Default N excretion of 1000 kg swine mass per day
Source of data to be used:	Table 10.19, chapter 10, volume 4, IPCC 2006 Guidelines
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0.50
Description of measurement methods and procedures to be applied:	Monitored annually. Archive electronically during project plus 5 years.
QA/QC procedures to be applied:	---
Any comment:	---

B.7.2 Description of the monitoring plan:

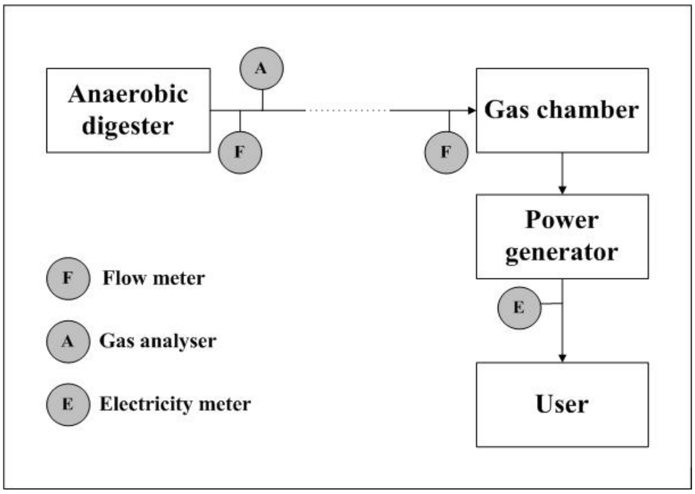
>>

Management and operational structure

Muyuan Company has established a CDM project office to take charge of the monitoring tasks of the project, and one specific staff was appointed to collect and archive the monitored data and invite a qualified company to calibrate the monitoring equipments once a year. The monitoring staffs in every subsidiary will take charge of the implementation of the monitoring tasks and they will monitor the parameters according to the requirements of the monitoring plan and directly report to the CDM project office. The monitoring staffs will be trained regularly in order to satisfactorily fulfill their monitoring obligations. The monitoring equipments will be regularly maintained and calibrated to ensure the accuracy. The management structure is illustrated as follows:



Parameters to be monitored



(1) Livestock population and weight: The responsibility of monitoring and registering this parameter relies on each swine barn's operators, swine population and weight is part of the production schedule of Muyuan.

(2) Biogas flow: The biogas generated in the project activity is supplied to the generator through gas chamber and the pipeline from the gas chamber to the generator is too short, so only two flow meters are installed, one is installed at the outlet of the anaerobic digester and the other one is installed at the inlet of the gas chamber. Flow meters will undergo maintenance/calibration subject to appropriate industry standards. The biogas generated from the anaerobic digester is monitored and registered by the operator in charge of the manure treatment system's operation, and the biogas input to the gas chamber is monitored and registered by the operator in charge of the power generator. Registered daily and reported cumulatively to the CDM project office on weekly basis.

(3) Methane fraction of biogas: Methane content will be measured continuously with a fixed gas analyser installed at the outlet of the anaerobic digester by the project proponents. It is monitored and registered by the operator in charge of the manure treatment system's operation and reported to the CDM project office on weekly basis.

(4) Electricity generation: Methane content will be measured continuously with a flow meter installed on

the power generator. The registration of this parameter relies on the operator of the generator. The purpose of monitoring this parameter is to confirm the correct performance of the generator.

(5) Other parameters are taken from published sources such as IPCC 2006 Guidelines and US-EPA (2001), they should be updated on latest available public data source.

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

>> Date of completion of the application of the baseline and monitoring methodology(DD/MM/YY)：
20/12/2006

Name of person(s)/entitiy(ies) responsible for the application of the baseline study and monitoring methodology to the project activity:
Ma Zhan, Tsinghua University International Technology Transfer Center
Telephone number: +86 13701126939
E-mail: mazhan@tsinghua.org.cn

The person/entitiy responsible for the application of the baseline study and monitoring methodology is not project participants.

SECTION C. Duration of the project activity / crediting period

C.1 Duration of the project activity:

C.1.1. Starting date of the project activity:

>> The starting date of the project is define to be the data when the project is actually on operation and is expected to be April 1st, 2007.

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

>> The expected operational lifetime of the project activity is 15 years.

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

C.2.1. Renewable crediting period

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

>> Not applicable

C.2.1.2. Length of the first crediting period:

>> Not applicable

C.2.2. Fixed crediting period:

C.2.2.1. Starting date:

>> 01/04/2007

C.2.2.2. Length:

>> 10 years

SECTION D. Environmental impacts

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

>> According to Article 13 of the Environmental Protection Law of the People's Republic of China, units constructing projects that cause pollution to the environment must observe the state provisions concerning environmental protection for such construction projects. The Environmental Impact Assessment (EIA) on a construction project must assess the pollution that the projects is likely to produce and its impact on the environment, and stipulate the preventive and curative measures; the statement shall, after initial examination by the authorities in charge of the construction project, be submitted by specified procedure to the competent department of environmental protection administration for approval. The department of planning shall not ratify the design plan descriptions of the construction project until after EIA on the construction project is approved. Muyuan has already carried out an EIA according to the law and the EIA table for the proposed project has been approved by Neixiang Environmental Protection Bureau in March 29th, 2005.

The animal manure methane recovery and utilization CDM project in Muyuan swine farm is an environmental protection project of resource reuse, and the project activity can promote the sustainable development of the host country and alleviate the pressure to the regional and global environment. The environmental impact of the project on the construction site is very little. The analysis of the potential environmental impacts of the project is described as follows:

1) Wastewater
The wastewater produced by this project is mainly the marsh liquid and household wastewater. The household wastewater is digested in the anaerobic digester and discharged with the marsh liquid afterward. The marsh liquid, which still contains nutrients, can be used as irrigation water directly, without potential threat to the groundwater and the rivers.

2) Waste gas
The facilities used in this project are mainly built hermetically, only a few of which are opened, thus the gas emitted during the operational process will be smelly. In order to alleviate the damage from the waste gas, green plants, like trees and grasses, are planted at the project site, making the green coverage area no less than 40%. The green plants can absorb deleterious gas, alleviate the odour, abate the noise and make the scenery of the site more enjoyable.

3) Solid waste
The activated sludge from the manure management system can be used as raw materials for compound fertilizer. Impurity, big suspended matter and stones of various diameters in the swine manure, which are not fit for integrated utilization, can be separated from the manure through sedimentation and percolation and sent to the refuse dumps to dispose.

4) Noises
The noises of the project are from equipment such as pumps and electricity generators. The pumps used in the project are low-noise pumps, whose outdoor sound level is less than 60dB(A). Sound insulation facilities are installed in the generators to deal with the noises and the noises afterward would be about 85dB(A) which confirm with the national regulations.

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

>> According to the EIA report table, the impacts of this project activity are very small. The project activity can mitigate the environmental pollutions caused by the manure from swine farms

SECTION E. Stakeholders' comments

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

>>

1. Public Inquiry

According to the requirements of related environmental protection law and regulations of the People's Republic of China and the requirements of the project design document, public survey should be carried out in related areas to collect people's opinions and advices on the implementation of the project, in order to improve the environmental and social benefits of the project activities.

The public survey of the manure treatment and methane recovery project in Muyuan swine farm is organized and implemented by environmental inspect station of Neixiang County on behalf of Muyuan in March, 2005. The public survey was carried out in form of questionnaires which were preserved in the environmental checkpoint of Neixang County. The results of the survey were summarized as follows:

- **Means of Participation**

The public survey was conducted by sending and receiving questionnaires. The main construction contents of the project, proposed environmental protection measures, predictions of pollutant emissions were listed in the questionnaires. The staff carrying out the survey will explain related questions to public when necessary. The objects of the survey were farmers, staff of enterprises, related entities around the project site and so on. The survey followed the randomicity principal in order to make the survey to be fair and objective.

- **Main Contents of Public Survey**

1) The major pollutions brought by the construction of the project in the public concerns (including wastewater, waste gas, noises and so on).
2) The degree of environmental impact on the project site after implementation of the project.
3) Whether the construction of the project would bring benefits to the economy and employment of this region.
4) Support the project or not.
5) Other advices on the construction of the project.

- **Statistics of Survey Objects**

In the public survey of the environmental evaluation, 35 individual questionnaires and 8 entity questionnaires were sent in total. 35 individual questionnaires and 8 entity questionnaires were received afterward. Basic information of the survey objects are shown below.

Statistics of Organizations

Organization Characters	Number	Organization in detail
Institution, enterprises	5	Neixiang Agriculture Administration, Neixiang Livestock Administration, Neixiang Energy Station, Guanzhang Town Government, Feiya Food Company.
Village committee nearby	3	Shuitian Village Committee, Hexi Village Committee, Laozhuang Village Committee

Statistics of Individuals

Category		Person	Proportion (%)
Gender	Male	24	63
	Female	11	37

2. Environmental Impact Evaluation Announcements

Announcements were posted on four call-boards around the project site in March, 2005. The main construction contents of the project, proposed environmental protection measures, predictions of pollutant emissions were indicated in the announcements. The public opinions and advices on the construction of the project were received via telephone or mail.

E.2. Summary of the comments received:

>> The comments are summarized as follows:

- 100% investigators think the implementation of the project will not cause bad effects.
- 95% investigators think the implementation of the project can improve the living condition of the people around, 5% think the influence is insignificant.
- 91% investigators think the project can promote local economic development and increase the income of the farmers around.
- 100% investigators support the implementation of the project.

In summary, most of the people think that the implementation of the project will not influence their life significantly. During the period of public announcement, no negative opinions were received against the construction of the project. All the stakeholders supported the construction of the project and were looking forward to the operation of the project as soon as possible.

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

>> During the construction and operation process of the project, the company should consider the public opinions and advices seriously. The measures given by the EIA report table should be followed seriously to achieve the unification of the environmental, social and economic benefits. The individuals around and the local government were very supportive to this project. No negative opinions were received. According to the comments received, the project does not need adjustment.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

Organization:	Muyuan Livestock Feeding Co., Ltd., Neixiang County, Henan Province.
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Annex 2

INFORMATION REGARDING PUBLIC FUNDING

There is no Official Development Assistance (ODA) from Parties included in Annex I involved in this project.

Annex 3

BASELINE INFORMATION

Table3-1 General data of Project's Operation

	Gangtou	Hexi	Laozhuang	Maping	Shuitian	Fangang	Total
Number of swine heads (head)	20,000	21,000	30,000	42,500	50,000	25,000	188,500
Average swine weight (kg)	72	77.62	68.3	55.3	70	86	69.6
Effective operation days	365	365	365	365	365	365	365

Source: Muyuan Livestock Feeding Company, Neixiang County, Henan Province

Annex 4

MONITORING INFORMATION

There is no further monitoring information to provide.