**CLEAN DEVELOPMENT MECHANISM**
**PROJECT DESIGN DOCUMENT FORM (CDM-SSC-PDD)**
**Version 03 - in effect as of: 22 December 2006**

**CONTENTS**

**Revision history of this document**

| Version Number | Date | Description and reason of revision |
|---|---|---|
| 01 | 21 January 2003 | Initial adoption |
| 02 | 8 July 2005 | • The Board agreed to revise the CDM SSC PDD to reflect guidance and clarifications provided by the Board since version 01 of this document.<br>• As a consequence, the guidelines for completing CDM SSC PDD have been revised accordingly to version 2. The latest version can be found at <http://cdm.unfccc.int/Reference/Documents>. |
| 03 | 22 December 2006 | • The Board agreed to revise the CDM project design document for small-scale activities (CDM-SSC-PDD), taking into account CDM-PDD and CDM-NM. |

## SECTION A. General description of small-scale project activity

### A.1 Title of the small-scale project activity:

Methane fired power generation plant in Samrong Thom Animal Husbandry, Cambodia (the Project or project activity)

Version 03

Completed on the 16th of September 2008

Deleted: 2

Deleted: November

Deleted: 2007

### A.2. Description of the small-scale project activity:

The purpose of the project activity is to recover the methane generated from the wastewater of Samrong Thom Animal Husbandry (STAH) piggery farm in Kien Svay district, Kandal province, Cambodia. STAH will install an anaerobic reactor digestion system to capture the methane generated from their wastewater. The recovered methane will be used to fuel a gas engine driven generator to supply the electricity requirements of the farm. The second phase of the Project will involve supply of electricity to other local users via a rural electricity enterprise (REE). This second phase of the project will be implemented once it has been established that the amount of electricity that can be generated from the recovered methane exceeds the farm's own needs.

The Project will capture and destroy the methane that would otherwise be emitted to the atmosphere in the absence of the project activity, and at the same time displace the use of diesel fuel for power generation. The expected amount of greenhouse gases emission reduction for the first crediting period is approximately 5,593 tonnes of $CO_2$ equivalent per annum on average.

Deleted: 6,262

**Contribution to Sustainable Development**

Cambodian Designated National Authority (DNA) presents a document regarding sustainable development criteria for proposed CDM activities[1]. The instruction in the document indicates that the PDD must outline how the project meets Cambodia's sustainable development objectives. The following illustrates how the Project meets the four criteria outlined in the instruction.

Environmental Protection and Improvement – the Project contributes to mitigation of global climate change by recovering and utilizing methane, a potent greenhouse gas, which would have otherwise been emitted into the atmosphere. At the same time, the recovered methane is utilized to generate electricity displacing carbon intensive fossil fuel based generating units. The Project does not cause negative environmental impacts. In fact, the Project enhances the condition of the local environment by employing this new technology. As it is more advanced method of treating animal waste compared to traditional practices, the overall sanitary conditions at the piggery are improved. It also eliminates much of the unpleasant odours produced by anaerobic lagoons by covering it for methane capture. And because the collected methane will be utilized as fuel, the Project also reduces air pollution from diesel fired generators that it will be replacing.

[1] The document is titled Cambodian Designated National Authority Clean Development Mechanism Assessment Procedures and available from the DNA.

Social – Enhancement of Income and Quality of Life – the Project brings social benefits to the neighbouring community by providing electricity. As described in Section E, STAH invited members of the neighbouring community to a public consultation meeting on April 29th, 2007. All the members expressed their support to the Project.

Technology Transfer – The project concept is new to Cambodia, and all elements needed for its implementation will have to be imported, including know-how transfer to local staffs. It is to be hoped that the implementation of this first of its kind project in Cambodia will enable increased confidence in the technology, encouraging the development of further similar projects to other animal husbandry facilities. Also, the technology selected for the Project improves the local environmental, economic and social conditions.

Economic Benefits – Utilizing the methane recovered from the anaerobic digestion system to generate electricity, the Project displaces the use of diesel oil and contributes greatly to decreasing dependency on imported fossil fuels. Cambodia has few fossil fuel resources of its own, and due to the low demand and underdeveloped delivery infrastructure, import of expensive fossil fuels is a drag on economic development and on the national trade balance. Also, since the excess electricity generated will be sold to neighbouring communities, the project activity provides a new supply of electricity and reduces dependence on imported energy. In addition, although most equipment for the Project will have to be imported, the construction, operation and maintenance will be implemented using local work force. This provides additional employment opportunities for local residents.

## A.3. Project participants:

| Name of Party involved (*) ((host) indicates a host Party) | Private and/or public entity(ies) project participants (*) (as applicable) | Kindly indicate if the Party involved wishes to be considered as project participant (Yes/No) |
|---|---|---|
| Cambodia (host) | **Samrong Thom Animal Husbandry** (Private entity) | No |
| Japan | **Clean Energy Finance Committee, Mitsubishi UFJ Securities Co., Ltd.** (Private entity) | 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. | | |

Formatted

In addition to being a project participant, Mitsubishi UFJ Securities is the CDM Advisor to the project and the contact for the CDM Project activity.

See contact information at Annex-1 of this PDD.

**A.4. Technical description of the small-scale project activity:**

**A.4.1. Location of the small-scale project activity:**

**A.4.1.1. Host Party(ies):**

Cambodia

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

Kandal Province

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

Phum Prek Treng, Khum Samrong Thom, Kien Svay District

**A.4.1.4. Details of physical location, including information allowing the unique identification of this small-scale project activity :**

The Project will be located at the STAH piggery farm which is at National Road No.1, Phum Prek Treng, Khum Samrong Thom, Kien Svay District in the province of Kandal. Coordinates are 11°23'40.86"N latitude, and 105°13'52.76"E longitude. Kien Svay District is one of the 11 districts of Kandal. Kandal is a province of Cambodia which completely surrounds, but does not include, the national capital Phnom Penh.


Figure 1 – Map of Cambodia

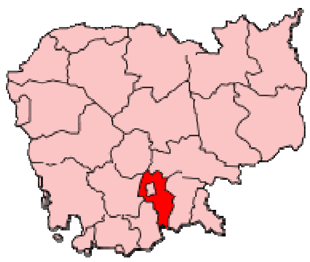


Figure 2 – Map of Cambodia highlighting Kandal Province

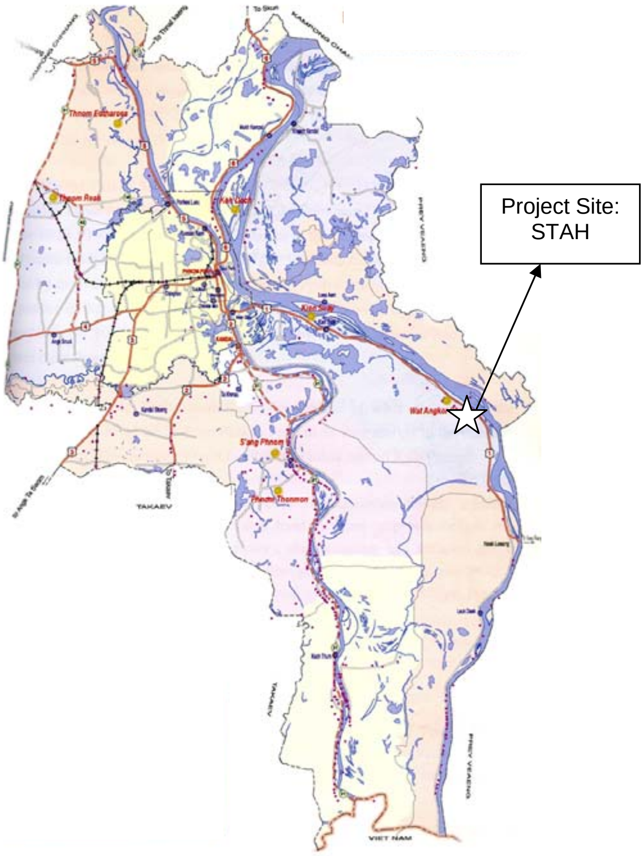



Figure 3 – Map of Kandal Province

**A.4.2. Type and category(ies) and technology/measure of the small-scale project activity:**

In accordance with Appendix B of the simplified modalities and procedures for small-scale CDM project activities ("SSC M&P"), the proposed Project falls under the following type and categories:

**Type I: Renewable energy projects**
**Category A: Electricity generation by the user**

STAH piggery farm does not have a grid connection. Its electricity demand, approximately 390,109 kWh per annum, is supplied by several units of diesel fired generators. The Project will produce electricity using renewable generating units, which will replace existing fossil fuel fired generators. The project activity conforms to applicability condition of Type I.A. since the total generation capacity of 200kW is less than the eligibility limit of 15MW.

At installed capacity of 200kW, the project activity can generate 1,314,000 kWh of electricity per annum, 390,109 kWh of which will supply the electricity demand of STAH piggery farm. The rest of the electricity generated will be sold to a rural electricity enterprise (REE) for distribution to nearby communities. However, baseline emissions will be claimed only for the portion of the electricity used by STAH piggery farm.

Deleted: ¶

**Type III: Other project activity**
**Category D: Methane recovery in agricultural and agro industrial activities**

The proposed project activity will recover and destroy methane from swine wastes from STAH piggery farm that would be decaying anaerobically in the absence of the project activity, via installation of methane recovery and combustion system to its existing wastewater. The Project was estimated to result in emission reductions of about 5,281 tCO2 equivalent per annum from methane recovery, which is less than 60,000 tonnes per year, complying with the limit placed on Type III.D project activities.

**Technology used in the project activity**

A covered anaerobic bio-digester, which is a simple but yet effective anaerobic digestion system, is opted to be installed as the primary wastewater treatment facility for the Samrong Thom Piggery Farm. Basically, the system comprises an inlet conduit(s) which is a closed channel where pig manure flows in. The manure through the inlet port is then kept in a lined and covered pond where the biochemical reaction occurs resulting in methane generation. The methane captured by the lagoon cover is then delivered via the outlet route to an internal combustion engine where the methane- combustion takes place.

The covered anaerobic bio-digester, with optimum operating temperature of 35 degree Celsius and operational temperatures ranging between 4 and 60 degrees Celsius[2], is designed to remove more than 85% of the BOD and 70% of the COD[3]. After treatment, effluent from the bio-digester will be stored in the existing lagoons. The first of which is an open lagoon measuring around 0.2 hectares in area and 3 meters deep. The overflow of this lagoon goes to the second open lagoon measuring about 0.8 hectares in area and 4 meters deep. Subsequently, effluent will be transferred to the third lagoon measuring around 1.7 hectares in area and 4.5 meters deep.

The covered anaerobic bio-digester consists of an earthen lagoon, excavated and compacted to treat the wastewater coming from the daily cleaning of the pig houses of the 1,500 sow farm. The digester cell will be lined with high-density polyethylene (HDPE) for liquid containment. HDPE will also be used to cover the pond, providing a gas seal to capture biogas for utilization as a fuel onsite.

Electricity generated is for farm demand and for sale as well. The biogas engine will displace the existing diesel generators of the farm. The farm currently has four operational diesel generation units with rated capacities of 1 x 250kVA, 2 x 220kVA and 1 x 120kVA respectively. Upon commissioning of the project activity, these diesel generators will be kept on standby as backup generation units to ensure sufficient supply of electricity to the farm should it be required.

[2] Specifications provided by technology supplier

[3] Section 4.2, Feasibility Study of a Methane-Fired Power Generation Plant in Kien Svay District, Kandal Province

When it has been confirmed that the methane generated from the covered anaerobic bio-digester will be sufficient to generate and supply excess electricity to nearby communities, the second phase of the Project will be implemented if STAH can find a reliable private distributor for this electricity. Excess electricity will be sold to an REE which will allow other local users, which currently source their electricity from battery charging stations, to have access to available electricity. STAH management is planning to decide by December 2008, whether implementation of the second phase of the Project will be practicable. However, baseline emissions will not be claimed for the sale of electricity to outside users.

The annual power generation then equals to the site demand plus the electricity sale which is:

| **Electricity generated at installed capacity (i.e. at 200 kWe, 10% parasitic load)** | **1,314,000 kWh** |
|---|---|
| Farm's electricity demand | 390,109 kWh |
| Excess electricity available | 923,891 kWh |
| Load factor (distribution losses included) | 65% |
| Electricity sale | 600,529 kWh |
| Total projected electricity generation | 990,638 kWh |

The power output and operational lifetime of the power plant depends on annual operating hours and maintenance. The system is designed in a way that the annual operating hour of 8760 hours, i.e. 24/7 operation, is achieved by running alternately two internal combustion engines. Under proper maintenance, a minimum lifetime of 15 years[4] could be expected, and the project owner intends to replace any failed equipment on an ongoing basis to enable a lifetime of at least 21 years.

In addition, it may be necessary to flare a portion of the biogas, using an open flare. The project owners have been advised that the system can be run without resorting to flaring. However, a flare will be installed as necessary, as a contingency measure if there is a problem with the gas engines, or if an increase in pig numbers leads to a surplus of gas. For purposes of transparency, the provision for flaring has been added to the PDD, along with the necessary provisions for monitoring.

Deleted: they believe that there is a possibility that a flare will have to be installed in the future as a contingency measure

Deleted: it may become necessary to install

### A.4.3 Estimated amount of emission reductions over the chosen crediting period:

The following table shows the estimated amount of emission reductions over the 7-year crediting period.

| **Years** | **Annual estimation of emission reductions in tonnes of $CO_2$e** |
|---|---|
| 1st | 5,593 |
| 2nd | 5,593 |
| 3rd | 5,593 |
| 4th | 5,593 |
| 5th | 5,593 |

Formatted: Not Highlight

Deleted: 6,374

Formatted: Not Highlight

Formatted: Not Highlight

Deleted: 6,374

Formatted: Not Highlight

Deleted: 6,374

Formatted: Not Highlight

Deleted: 6,374

[4] Section 4.2, Feasibility Study of a Methane-Fired Power Generation Plant in Kien Svay District, Kandal Province

| | |
|---|---|
| 6th | 5,593 |
| 7th | 5,593 |
| Total estimated reductions (tonnes of $CO_2e$) | 39,151 |
| Total number of crediting years | 7 |
| Annual average over the crediting period of estimated reductions (tonnes of $CO_2e$) | 5,593 |

Formatted: Not Highlight
Deleted: 6,374
Deleted: 6,374
Formatted: Not Highlight
Deleted: 43,837
Formatted: Not Highlight
Deleted: 6,262

### A.4.4. Public funding of the small-scale project activity:

The Project does not involve public funding from Annex 1 countries.

### A.4.5. Confirmation that the small-scale project activity is not a debundled component of a large scale project activity:

This Project is not a debundled component of any larger project activity. As defined, a proposed small-scale project activity shall be deemed to be a debundled component of a large project activity if there is a registered small-scale CDM project activity or a request for registration by another small-scale project activity:

- By the same project participants;
- In the same project category and technology/measure; and
- Registered within the previous 2 years; and
- Whose project boundary is within 1 km of the project boundary of the proposed small-scale activity at the closest point.

None of the above is applicable to the Project.

## SECTION B. Application of a baseline and monitoring methodology

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

AMS-I.A. (Version 12) – Electricity generation by the user

AMS-III.D. (Version 13) – Methane recovery in agricultural and agro industrial activities

### B.2 Justification of the choice of the project category:

The project activity conforms to the applicability condition of Type I.A – Electricity generation by the user under Appendix B of the SSC M&P as demonstrated in the table below:

| Applicability Criteria for Type I.A. | Project Activity |
|---|---|
| 1. This category comprises renewable energy generation units that supply individual households or users or groups of households or users with electricity. The applicability is limited to households and users that do not have a grid | The Project is a renewable energy generation technology that supply electricity to STAH piggery, which does not have a grid connection, replacing its existing fossil fuel |

Deleted: farm and nearby communities

| | |
|---|---|
| connection except when a group of households or users are supplied electricity through an isolated1 mini-grid where the capacity of the generating units shall not exceed 15 MW. These units include technologies such as solar power, hydropower, wind power, and other technologies that produce electricity all of which is used on-site by the user, such as solar home systems, and wind battery chargers. The renewable generating units may be new or replace existing fossil fuel fired generation. The capacity of these renewable energy generators shall not exceed 15 MW. | fired generation. The Project's generating capacity is 200kW, which is less than the eligibility limit of 15MW. |
| 2. Combined heat and power (co-generation) systems are not eligible under this category. | The project activity will be utilizing a biogas fired power generation system, and does not involve combined heat and power systems. |
| 3. If the unit added has both renewable and non-renewable components (e.g. a wind/diesel unit), the eligibility limit of 15MW for a small-scale CDM project activity applies only to the renewable component. If the unit added co-fires [non-] renewable biomass and fossil fuel, the capacity of the entire unit shall not exceed the limit of 15MW. | The units used for the Project, which are biogas fired generators, has a total capacity of 200kW, not exceeding the limit of 15MW. |
| 4. Project activities that seek to retrofit or modify an existing facility for renewable energy generation are included in this category. To qualify as a small-scale project, the total output of the modified or retrofitted unit shall not exceed the limit of 15 MW. | The project activity does not involve retrofit or modification of an existing facility. |
| 5. In the case of project activities that involve the addition of renewable energy generation units at an existing renewable power generation facility, the added capacity of the units added by the project should be lower than 15 MW and should be physically distinct from the existing units. | The project activity does not involve the addition of renewable energy generation units at an existing renewable power generation facility. The Project will replace STAH's existing diesel generation system. |

The project activity conforms to the applicability condition of Type III.D – Methane recovery in agricultural and agro industrial activities under Appendix B of the SSC M&P as demonstrated in the table below:

| **Applicability Criteria for Type III.D.** | **Project Activity** |
|---|---|
| 1. This project category comprises methane recovery and destruction from manure and wastes from agricultural or agro-industrial activities that would be decaying anaerobically in the absence of the project activity by:<br>(a) Installing methane recovery and combustion system to an existing source of methane emissions, or<br>(b) Changing the management practice of a biogenic waste or raw material in order to achieve the controlled anaerobic digestion equipped with methane recovery and combustion system. | The Project recovers and destroys methane from manure and wastes from STAH piggery farm that would be decaying anaerobically in the absence of the project activity by installing methane recovery and combustion system to an existing source of methane emissions. |

| | |
|---|---|
| 2. The project activity shall satisfy the following conditions:<br>(a) The sludge must be handled aerobically. In case of soil application of the final sludge the proper conditions and procedures (not resulting in methane emissions) must be ensured.<br>(b) Technical measures shall be used (e.g. flared, combusted) to ensure that all biogas produced by the digester is used or flared. | (a) Sludge collected from the project activity, frequency of about 2 to 3 years, will be handled aerobically by drying in open field and sold as fertilizer to neighboring communities.<br>(b) The project activity utilizes and combusts the biogas produced by the digesters to generate electricity (with possibility of some amount of flaring). Therefore, biogas produced by the digester is destroyed. |
| 3. Projects that recover methane from landfills shall use category III-G and projects for wastewater treatment shall use category III-H. | The Project recovers and destroys methane from manure and waste from agricultural or agro-industrial activities and therefore applicable under category III-D. |
| 4. Measures are limited to those that result in emission reductions of less than or equal to 60 kt CO2 equivalent annually. | Estimated emission reduction for methane recovery is approximately 5,281 tonnes $CO_2$ equivalent annually, which is less than the eligibility limit of 60 kt$CO_2$e/yr. |

## B.3. Description of the project boundary:

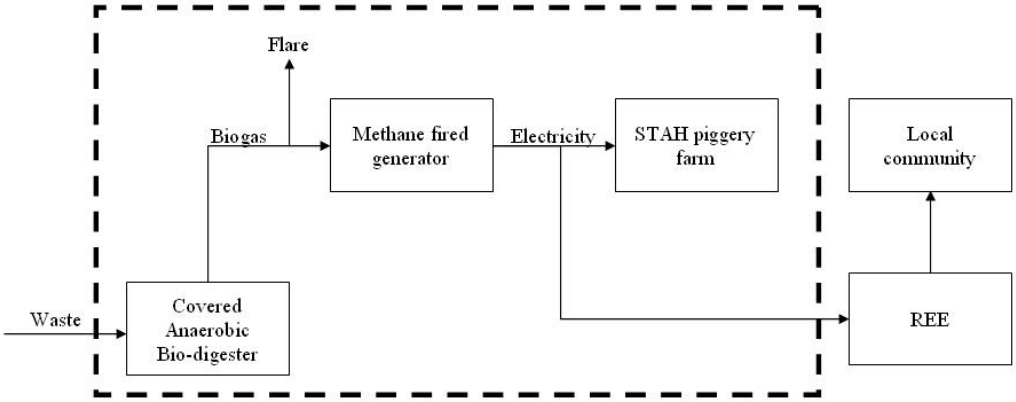
In accordance with paragraph 6 of Type I.A., Appendix B of the simplified modalities and procedures for small-scale CDM project activities, the project boundary for the project activity is defined as follows:

> "The physical, geographical site of the renewable energy generating unit and the equipment that uses the electricity produced delineates the project boundary."

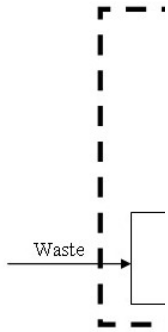
In accordance with paragraph 5 of Type III.D., Appendix B of the simplified modalities and procedures for small-scale CDM project activities, the project boundary for the project activity is defined as follows:

> "The project boundary is the physical, geographical site of the methane recovery facility."

The illustration below shows the flowchart of the Project and its boundaries.




Deleted:




Formatted: English (U.S.)

Figure 5 – Project boundary

Deleted: <<Will amend in final draft to include flare and to move REE outside Project Boundary)>>

## B.4. Description of baseline and its development:

The calculation of the baseline emissions for electricity generation is conducted in accordance with the instructions provided in paragraph 7 option (b) and paragraph 10 of Type I.A, Appendix B of the simplified modalities and procedures for small-scale CDM project activities. The energy baseline is the fuel consumption of the technology in use or that would have been used in the absence of the project activity. The following energy baseline formula was used:

$$E_B = \sum_i O_i/(1-l)$$

Where:

$E_B$ annual energy baseline in kWh per year

$\sum_i$ the sum over the group of "i" renewable energy technologies (e.g. solar home systems, solar pumps) implemented as part of the project.

$O_i$ the estimated annual output of the renewable energy technologies of the group of "i" renewable energy technologies installed (in kWh per year). In the Project case, $O_i$ is the annual output of the biogas-powered gas engines, net of any electricity exported to outside users.

l average technical distribution losses that would have been observed in diesel powered mini-grids installed by public programmes or distribution companies in isolated areas, expressed as a fraction.

Under paragraph 10 of Type I.A, a default value 0.8 KgCO2e/kWh which is derived from diesel generation units, may be used for option 7(a) and 7(b). A small-scale project proponent may, with adequate justification use a higher emissions factor from Table I.D.1 under category I.D.

The calculation of the baseline emissions for methane recovery is conducted in accordance with the instructions provided in paragraph 7 of Type III.D, Appendix B of the simplified modalities and procedures for small-scale CDM project activities. Baseline emissions are calculated ex-ante using the amount of the waste or raw material that would decay anaerobically in the absence of the project activity, with the most recent IPCC tier 2 approach (please refer to the chapter 'Emissions from Livestock and Manure Management' under the volume 'Agriculture, Forestry and other Land use' of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories).

Equations used for the calculation of project emissions, baseline emissions, leakage emissions and emission reductions for all project categories, are applied to the project activity, as explained in Section B.6.3.

## 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 small-scale CDM project activity:

The Project will reduce greenhouse gas emissions in three ways as described below:

1. By installing a closed anaerobic digestion system, methane emissions from the anaerobic decay of animal wastes that would have been produced and emitted into the atmosphere in the absence of the project activity, will be recovered and destroyed.

2. The recovered methane will be used as fuel to provide the electricity requirements of STAH piggery farm, replacing its use of diesel, a carbon intensive fossil fuel.

3. Excess electricity generated by the methane fired generators will be sold to an REE, providing rural electrification to nearby communities. This provides electricity to other local users currently sourcing their electricity from battery charging stations which are operated by diesel based generating units. However, CERs will not be claimed for this portion of the Project, which is a conservative approach.

The implementation of the project activity is hindered by the following barriers.

**Technological barrier**

The Project represents the first animal waste methane capture and utilization project implemented in Cambodia. The technology choice for the Project is the covered anaerobic bio-digestion system as described in Section A.4.2. This will be the first time for a methane recovery project to be implemented at a piggery in Cambodia. All of the equipment and most of the key materials for the project must be sourced by importing, in particular the polythene sheeting for the liner and gas collection, and the gas engines. Spare parts may be difficult to obtain within Cambodia, resulting in increased costs and potential time delays when repairs are required.

Further, examples of other CDM piggery wastewater methane extraction projects have shown very mixed results, and there can be no certainty that sufficient gas will be extracted to ensure the smooth running of the gas engines.

Further, as a new technology to Cambodia, potential equipment operators will be unfamiliar with the basic operation and maintenance of the new system. Operators will need to undergo a comprehensive training program in order to operate the installation efficiently and safely. The application of the new technology for the first time in the country would be too risky to implement without the additional financial incentive of revenue from CERs.

**Barrier due to prevailing practice**

This project is the first of its kind in Cambodia. There are currently no regulations that specify which type of treatment system to be employed for wastewater. The Law on Environmental Protection and Natural Resources Management, Sub-Decree on Water Pollution Control, specifies the standards for effluent discharge and pollution loads for 52 parameters. It states that project owners are responsible for implementing wastewater treatment methods that comply with the effluent standards as stipulated in the sub-decree. However, STAH's current lagoon system is sufficient for ensuring compliance with these standards. There is no legal compulsion for the project developer to carry out any reduction of methane emissions under Cambodian law.

As the open anaerobic lagoon system is the typical swine waste treatment employed in Cambodia and other developing nations, STAH sees this project as having significant risk, beyond the risks associated with running their current, tried and tested anaerobic lagoon. As can be seen in the feasibility study conducted by The Cambodian Research Centre for Development (CRCD) together with its partners Centre Wallon de Recherches agronomiques (CRA-W) of Belgium, Risø National Laboratory of Denmark and Emerging Power Partners Limited of Finland, and co-financed grant by the European

Commission, it is clear that the Project was conceptualized in consideration of CDM. It is apparent that without incentives in the form of carbon credits, STAH will take a less risky approach and simply continue its current practice resulting in emission of greenhouse gases into the atmosphere.

**Common practice barrier**

According to a publication on the feasibility study[5] conducted in December 2005, all of the piggery farms surveyed in Cambodia use the same basic effluent disposal process that involved drainage to a series of between 1 to 10 open lagoons. In addition, the electricity used in these farms is being generated by diesel fired generators.

Evidently, as explained in the barrier due to prevailing practice above, this Project is the first of its kind in Cambodia. Without the assistance of CDM, it is likely that STAH would continue this common industry practice resulting in continuous emission of greenhouse gases into the atmosphere.

**Summary**

Faced with the barriers outlined above, the Project will not be carried out in the course of regular business, and can therefore be considered additional. The project has only been initiated thanks to an EC-ASEAN funded feasibility study, which clearly highlighted the potential of the project for CDM. The project owner only decided to go ahead with the project after learning of the potential benefits of CDM, with an awareness that the cushion of extra income from CER sales could make up for poor technical performance in this first of its kind project for Cambodia.

## B.6. Emission reductions:

### B.6.1. Explanation of methodological choices:

The calculation of the baseline emissions for electricity generation is conducted in accordance with the instructions provided in paragraph 7 option (b) and paragraph 10 of Type I.A, Appendix B of the simplified modalities and procedures for small-scale CDM project activities. The energy baseline is the fuel consumption of the technology in use or that would have been used in the absence of the project activity. The following energy baseline formula was used:

$$E_B = \sum_i O_i/(1-l)$$

Where:

$E_B$ annual energy baseline in kWh per year

$\sum_i$ the sum over the group of "i" renewable energy technologies (e.g. solar home systems, solar pumps) implemented as part of the project.

$O_i$ the estimated annual output of the renewable energy technologies of the group of "i" renewable energy technologies installed (in kWh per year)

$l$ average technical distribution losses that would have been observed in diesel powered mini-grids installed by public programmes or distribution companies in isolated areas, expressed as a fraction.

[5] Page 6, Renewable Energy Resources Map of Cambodia and Clusters/Markert Packages for Feasibility Studies

Under paragraph 10 of Type I.A, a default value 0.8 KgCO2e/kWh which is derived from diesel generation units, may be used for option 7(a) and 7(b). A small-scale project proponent may, with adequate justification use a higher emissions factor from Table I.D.1 under category I.D, as shown in the figure below.

**Table I.D.1**

**Emission factors for diesel generator systems (in kg $CO_2e$/kWh*) for three different levels of load factors****

| Cases: | Mini-grid with 24 hour service | i) Mini-grid with temporary service (4-6 hr/day)<br>ii)Productive applications<br>iii) Water pumps | Mini-grid with storage |
|---|---|---|---|
| Load factors [%] | 25% | 50% | 100% |
| <15 kW | 2.4 | 1.4 | 1.2 |
| >=15 <35 kW | 1.9 | 1.3 | 1.1 |
| >=35 <135 kW | 1.3 | 1.0 | 1.0 |
| >=135<200 kW | 0.9 | 0.8 | 0.8 |
| > 200 kW*** | 0.8 | 0.8 | 0.8 |

*) A conversion factor of 3.2 kg $CO_2$ per kg of diesel has been used (following revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories)
**) Figures are derived from fuel curves in the online manual of RETScreen International's PV 2000 model, downloadable from http://retscreen.net/
***) default values

The calculation of the baseline emissions for methane recovery is conducted in accordance with the instructions provided in paragraph 7 of Type III.D, Appendix B of the simplified modalities and procedures for small-scale CDM project activities. Baseline emissions are calculated ex-ante using the amount of the waste or raw material that would decay anaerobically in the absence of the project activity, with the most recent IPCC tier 2 approach (please refer to the chapter 'Emissions from Livestock and Manure Management' under the volume 'Agriculture, Forestry and other Land use' of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories).

Equations used for the calculation of project emissions, baseline emissions, leakage emissions and emission reductions for all project categories, are applied to the project activity, as explained in Section B.6.3.

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

| **Data / Parameter:** | $EF_{Diesel,STAH}$ |
|---|---|
| Data unit: | $kgCO_2e/kWh$ |
| Description: | Emission factor for diesel generator systems in STAH piggery farm |
| Source of data used: | AMS-I.D |
| Value applied: | 0.8 |

| | |
|---|---|
| Justification of the choice of data or description of measurement methods and procedures actually applied : | Default value applied as per instructions in the methodology. |
| Any comment: | |

Deleted: ¶
~~Data / Parameter:~~ ... [1]

| **Data / Parameter:** | $\mathbf{EF}_{swine}$ |
|---|---|
| Data unit: | $kgCH_4$/swine/yr |
| Description: | Annual $CH_4$ emission factor for swine |
| Source of data used: | Calculated |
| Value applied: | 17.021 |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | Value calculated as per instructions in the methodology |
| Any comment: | |

| **Data / Parameter:** | $\mathbf{VS}_{swine}$ |
|---|---|
| Data unit: | kgVS/swine/day |
| Description: | Daily volatile solid excreted for swine |
| Source of data used: | 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Vol.4 Ch.10, Table 10A-7 |
| Value applied: | 0.3 |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | Value applied as per instructions in the methodology |
| Any comment: | |

| **Data / Parameter:** | $\mathbf{B}_{o,\ swine}$ |
|---|---|
| Data unit: | $m^3CH_4$/kgVS |
| Description: | Maximum methane producing capacity for manure produced by swine |
| Source of data used: | 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Vol.4 Ch.10, Table 10A-7 |
| Value applied: | 0.29 |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | Value applied as per instructions in the methodology |
| Any comment: | |

| Data / Parameter: | MCF |
|---|---|
| Data unit: | Fraction |
| Description: | Methane conversion factor for manure management system by climate region |
| Source of data used: | 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Vol.4 Ch.10, Table 10A-7 |
| Value applied: | 0.8 |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | Value applied as per instructions in the methodology. Annual average temperature is 27.75 $^{o}$C[6]. |
| Any comment: | |

| Data / Parameter: | MS |
|---|---|
| Data unit: | Dimensionless |
| Description: | Fraction of swine manure handled using manure management system |
| Source of data used: | Project design |
| Value applied: | 1 |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | All of the swine manure produced by the farm will be handled by the manure management system |
| Any comment: | |

| Data / Parameter: | $SFC_{Biogas}$ |
|---|---|
| Data unit: | $m^3$/kWh |
| Description: | Specific fuel consumption, biogas, per unit of electricity generated |
| Source of data used: | Calculated |
| Value applied: | 0.28055 |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | Value applied was calculated as per instructions in the methodology for Type-I.A projects. Details of the calculations are shown in section B.6.3 below. |
| Any comment: | |

| Data / Parameter: | $NCV_{Biogas}$ |
|---|---|
| Data unit: | GJ/t |
| Description: | Net calorific value of biogas |
| Source of data used: | 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Vol.2 Ch.1, |

6 http://www.bbc.co.uk/weather/world/city_guides/results.shtml?tt=TT002520

| | Table 1.2 |
|---|---|
| Value applied: | 50.4 |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | Data necessary for the calculation of potential electricity generation from the amount of biogas collected. |
| Any comment: | |

| **Data / Parameter:** | **Eff** |
|---|---|
| Data unit: | Fraction |
| Description: | Efficiency of the biogas engine |
| Source of data used: | Supplier specifications |
| Value applied: | 0.38 |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | Data necessary for the calculation of potential electricity generation from the amount of biogas collected. Efficiency specification of the biogas engine has been provided by the technology supplier. |
| Any comment: | |

### B.6.3 Ex-ante calculation of emission reductions:

**Baseline emissions for electricity generation**

*For STAH piggery farm use*

As indicated in paragraph 7 of Type I.A, Appendix B of the simplified modalities and procedures for small-scale CDM project activities, the energy baseline is the fuel consumption of the technology in use or that would have been used in the absence of the project activity. The project participants may use one of the three options provided in the methodology. Option (b) was selected and the following energy baseline formula was used:

$$E_{STAH,y} = \sum_i O_{i,y} / (1 - l)$$

Where:

$E_{STAH,y}$ annual energy baseline in kWh in the year "y" for STAH piggery farm use

$\sum_i$ the sum over the group of "i" renewable energy technologies (e.g. solar home systems, solar pumps) implemented as part of the project. The project activity consists of only one renewable energy technology, the biogas electricity generation.

$O_{i,y}$ the annual output of the renewable energy technologies of the group of "i" renewable energy technologies installed (net output from gas engines, minus amount of electricity (if any) exported to outside users) in kWh in the year "y". The STAH farm has an estimated annual electricity consumption of 390,109 kWh.

Deleted: (

Deleted: )

l average technical distribution losses that would have been observed in diesel powered mini-grids installed by public programmes or distribution companies in isolated areas, expressed as a fraction. As the electricity generated will be used directly by STAH farm, no mini-grid or distribution systems will be involved. Therefore, value used is zero (0).

And where $O_{i,y}$ is calculated as:

$O_{GE,y}$ Net output of gas engines after parasitic consumption (kWh/year)
$O_{Ex,y}$ Annual export of electricity to outside users (kWh/year)

Therefore:
(note that this assumes maximum predicted gas availability, and successful implementation of the plan to export electricity to outside users)

| | | | | |
|---|---|---|---|---|
| Annual output, $O_{i,y}$ (kWh/year) | = | Net output of gas engines $O_{GE,y}$ (kWh/year) | - | Annual export of electricity to outside users $O_{Ex,y}$ (kWh/year) |
| Annual output, $O_{i,y}$ (kWh/year) | = | 990,638 (kWh/year) | - | 600,529 (kWh/year) |
| Annual output, $O_{i,y}$ (kWh/year) | = | 390,109 (kWh/year) | | |

| | | | | |
|---|---|---|---|---|
| Energy baseline, $E_{STAH,y}$ (kWh/year) | = | Annual output, $O_{i,y}$ (kWh/year) | / | (1-0) |
| Energy baseline, $E_{STAH,y}$ (kWh/year) | = | 390,109 (kWh/year) | / | (1-0) |
| Energy baseline, $E_{STAH,y}$ (kWh/year) | = | 390,109 | | |

Under paragraph 10 of Type I.A, a default value 0.8 kg$CO_2$e/kWh which is derived from diesel generation units, may be used for option 7(a) and 7(b). A small-scale project proponent may, with adequate justification use a higher emissions factor from Table I.D.1 under category I.D, as shown in the figure below.

**Table I.D.1**

**Emission factors for diesel generator systems (in kg $CO_2e$/kWh*) for three different levels of load factors****

| Cases: | Mini-grid with 24 hour service | i) Mini-grid with temporary service (4-6 hr/day)<br>ii)Productive applications<br>iii) Water pumps | Mini-grid with storage |
|---|---|---|---|
| Load factors [%] | 25% | 50% | 100% |
| <15 kW | 2.4 | 1.4 | 1.2 |
| >=15 <35 kW | 1.9 | 1.3 | 1.1 |
| >=35 <135 kW | 1.3 | 1.0 | 1.0 |
| >=135<200 kW | 0.9 | 0.8 | 0.8 |
| > 200 kW*** | 0.8 | 0.8 | 0.8 |

*) A conversion factor of 3.2 kg $CO_2$ per kg of diesel has been used (following revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories)
**) Figures are derived from fuel curves in the online manual of RETScreen International's PV 2000 model, downloadable from http://retscreen.net/
***) default values

The formula is expressed as follows:

| | | | | | | |
|---|---|---|---|---|---|---|
| Baseline emission $BE_{STAH,y}$ ($tCO_2e$/year) | = | Energy baseline, $E_{STAH,y}$ (kWh/year) | x | Emission factor for diesel generation system, $EF_{Diesel,STAH}$ ($kgCO_2e$/kWh) | x | 1 $tCO_2e$ / 1,000 $kgCO_2e$ |
| Baseline emission $BE_{STAH,y}$ ($tCO_2e$/year) | = | 390,109 (kWh/year) | x | 0.8 ($kgCO_2e$/kWh) | x | 1 $tCO_2e$ / 1,000 $kgCO_2e$ |
| Baseline emission $BE_{STAH,y}$ ($tCO_2e$/year) | = | 312 | | | | |

As per instructions in paragraphs 17 of the methodology, the specific fuel consumption, the fuel consumption per unit of electricity generated, of each type of fuel to be used should be specified ex-ante. The specific fuel consumption is calculated as follows:

| | | | | |
|---|---|---|---|---|
| Specific fuel consumption, $SFC_{Biogas}$ | = | Amount biogas collected and utilized, | / | Potential electricity generation from biogas, $PE_{Biogas}$ |

**Deleted:** *For export to REE*¶
¶
Similar to the calculation of baseline emission from electricity generation for the use of STAH piggery farm, the calculation of baseline emission from supplying excess electricity to an REE is conducted according to paragraph 7, option (b) of AMS-I.A:¶
¶
$E_{REE,y} = \sum_i O_{i,y} / (1 - l)$¶
¶
Where:¶
¶
$E_{REE,y}$ annual energy baseline in kWh in the year "y" for export to REE¶
¶
Therefore:¶
¶
Energy baseline, ¶
$E_{REE,y}$¶
(kWh/year)
... [2]

| ($m^3$/kWh) | $BG_{Burnt,y}$ ($m^3$/year) | (kWh/year) |
|---|---|---|

The amount of biogas collected and utilized is calculated based on the most recent IPCC tier 2 approach, and is expressed as follows:

$$BG_{Burnt,y} = \frac{VS_{swine} \bullet 365 \bullet B_{o,swine} \bullet MCF \bullet MS_{swine} \bullet P_{swine,y}}{w_{CH4,y}}$$

Where:

$VS_{swine}$ = daily volatile solid excreted for swine, kgVS/swine/day
365 = basis for calculating annual VS production, days/yr
$B_{o,\ swine}$ = maximum methane producing capacity for manure produced by swine, $m^3CH_4$/kgVS
MCF = methane conversion factor for manure management system by climate region
$MS_{swine}$ = fraction of swine manure handled using manure management system, dimensionless
$P_{swine,y}$ = annual swine population in STAH farm
$w_{CH4,y}$ = methane content of biogas, fraction

STAH's swine population for the year 2006 is shown in the table below.

| Month (2006) | Swine Population |
|---|---|
| January | 14,017 |
| February | 13,864 |
| March | 13,927 |
| April | 14,187 |
| May | 14,373 |
| Jun | 15,021 |
| July | 15,127 |
| August | 15,209 |
| September | 15,362 |
| October | 15,420 |
| November | 15,391 |
| December | 15,394 |
| AVERAGE | 14,774 |

Default values for $VS_{swine}$, $B_{o,\ swine}$, MCF and $MS_{swine}$ were obtained from Tables 10A-7 and 10A-8, Volume 4, Chapter 10 of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. For the purpose of estimation, the methane content of biogas, 0.65, was assumed based on technical specifications provided by the technology supplier. Therefore:

$$BG_{Burnt,y} = \frac{0.3\text{kgVS/swine/day x 365days/yr x 0.29m}^3\text{CH}_4\text{/kgVS x 0.8 x 1 x 14,774swines}}{0.65}$$

$BG_{Burnt,y}$ = 577,426 $m^3$/year

Similarly, the total potential electricity that can be generated was calculated as follows:

$$PE_{Biogas} = \frac{VS_{swine} \bullet 365 \bullet B_{o,swine} \bullet 0.67 \bullet MCF \bullet MS_{swine} \bullet P_{swine} \bullet NCV_{Biogas} \bullet 277.78 \bullet Eff}{w_{CH4,y} \bullet 1{,}000}$$

Where:

$NCV_{Biogas}$ = net calorific value of biogas, GJ/t
277.78 = conversion factor, kWh/GJ
Eff = efficiency of biogas engine, fraction

Default value for $NCV_{Biogas}$ was obtained from Table 1.2, Volume 2, Chapter 1 of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. The efficiency of the biogas engine, 0.38, was assumed based on technical specifications provided by the technology supplier. Therefore:

$$PE_{Biogas} = \frac{0.3 \times 365 \times 0.29 \times 0.67 \times 0.8 \times 1 \times 14{,}774 \times 50.4 \times 277.78 \times 0.38}{0.65 \times 1{,}000}$$

$PE_{Biogas}$ = 2,058,179 kWh/year

Therefore:

| | | | | |
|---|---|---|---|---|
| Specific fuel consumption, $SFC_{Biogas}$ ($m^3$/kWh) | = | Amount biogas collected and utilized, $BG_{Burnt,y}$ ($m^3$/year) | / | Potential electricity generation from biogas, $PE_{Biogas}$ (kWh/year) |
| Specific fuel consumption, $SFC_{Biogas}$ ($m^3$/kWh) | = | 577,426 ($m^3$/year) | / | 2,058,179 (kWh/year) |
| Specific fuel consumption, $SFC_{Biogas}$ ($m^3$/kWh) | = | 0.28055 | | |

As per instructions in paragraph 20 of methodology AMS-I.A, "The amount of electricity generated using biomass fuels calculated as per paragraph 17 (metered electricity generation) shall be compared with the amount of electricity generated calculated using specific fuel consumption and amount of each type of biomass fuel used. The lower of the two values should be used to calculate emission reductions."

The calculation for the amount of electricity generated based from specific fuel consumption, specified ex-ante, and amount of biomass fuel used, are as follows:

| | | | | |
|---|---|---|---|---|
| Calculated electricity generation, $E_{Calculated}$ | = | Amount biogas collected and utilized, | / | Specific fuel consumption, $SFC_{Biogas}$ |

| | | |
|---|---|---|
| (kWh/year) | $BG_{Burnt,y}$ ($m^3$/year) | ($m^3$/kWh) |

**Baseline emissions for methane recovery**

As indicated in paragraph 7 of Type III.D, Appendix B of the simplified modalities and procedures for small-scale CDM project activities, baseline emissions are calculated ex-ante using the amount of the waste or raw material that would decay anaerobically in the absence of the project activity, with the most recent IPCC tier 2 approach (please refer to the chapter 'Emissions from Livestock and Manure Management' under the volume 'Agriculture, Forestry and other Land use' of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories). The formula is expressed as follows:

$$\text{Baseline emission, } BE_{methane,y} \text{ (tCO}_2\text{e/year)} = \frac{\text{Swine population, } P_{swine,y} \text{ (swine)} \times \text{CH}_4 \text{ emission factor, } EF_{swine} \text{ (kgCH}_4\text{/swine/yr)} \times \text{Global warming potential of methane, } GWP_{CH4} \text{ (kgCO}_2\text{e/kgCH}_4\text{)}}{1{,}000 \text{ kgCO}_2\text{e/tCO}_2\text{e}}$$

The $CH_4$ emission factor was calculated in accordance with the most recent IPCC tier 2 approach, and is expressed as follows:

$$EF_{swine} = VS_{swine} \bullet 365 \bullet B_{o,swine} \bullet 0.67 kg / m^3 \bullet MCF \bullet MS_{swine}$$

Where:

$EF_{swine}$ = annual $CH_4$ emission factor for swine, $kgCH_4$/swine/yr
$VS_{swine}$ = daily volatile solid excreted for swine, kgVS/swine/day
365 = basis for calculating annual VS production, days/yr
$B_{o, swine}$ = maximum methane producing capacity for manure produced by swine, $m^3CH_4$/kgVS
0.67 = conversion factor of $m^3CH_4$ to $kgCH_4$
MCF = methane conversion factor for manure management system by climate region
$MS_{swine}$ = fraction of swine manure handled using manure management system, dimensionless

Default values for $VS_{swine}$, $B_{o, swine}$, MCF and $MS_{swine}$ were obtained from Tables 10A-7 and 10A-8, Volume 4, Chapter 10 of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Therefore:

$EF_{swine}$ = 0.3kgVS/swine/day x 365days/yr x 0.29$m^3CH_4$/kgVS x 0.67kg/$m^3$ x 0.8 x 1

$EF_{swine}$ = 17.021 $kgCH_4$/swine/yr

Baseline emissions are then calculated as:

$$\text{Baseline emission, } BE_{methane,y} \text{ (tCO}_2\text{e/year)} = \frac{14{,}774 \text{ (swine)} \times 17.021 \text{ (kgCH}_4\text{/swine/yr)} \times 21 \text{ (kgCO}_2\text{e/kgCH}_4\text{)}}{1{,}000 \text{ kgCO}_2\text{e/tCO}_2\text{e}}$$

| | | |
|---|---|---|
| Baseline emission, $BE_{methane,y}$ ($tCO_2e$/year) | = | 5,281 |

In the event of the installation of a flare, as described in section A.4.2 above, the portion of gas combusted in the flare and that destroyed by the gas engines will be monitored separately.

**Project emissions**

For the power generation component, Type I.A, Appendix B of the simplified modalities and procedures for small-scale CDM project activities, does not require project emissions calculations.

For methane recovery, as indicated in paragraph 6 of Type III.D, Appendix B of the simplified modalities and procedures for small-scale CDM project activities, project emissions consist of $CO_2$ emissions from use of fossil fuels or electricity for the operation of the facility. The project activity will be operated solely using methane collected from the anaerobic digestion system, and approximately 10% of the electricity generated will be parasitic load used to operate the facility. There are no project emissions associated with the project activity.

Therefore, total project emission is zero.

However, should the project activity result in the use of fossil fuel, the following equations will be used for the calculation of project emissions:

| | | | | |
|---|---|---|---|---|
| Project emission $PE_y$ ($tCO_2$/year) | = | Fossil fuel consumption, $FF_j$ (TJ/year) | x | $CO_2$ emission factor of fossil fuel used, $COEFF_j$ ($tCO_2$/TJ) |

Where:

| | |
|---|---|
| $PE_y$ | project emissions in the year "y" |
| $FF_j$ | amount of fossil fuel "j" consumed in TJ/year |
| $COEFF_j$ | default $CO_2$ emission factor for combustion of fossil fuel "j" in $tCO_2$/TJ, obtained from Table 1.4, Volume 2, Chapter 1 of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories |

**Leakage**

For the power generation component, Type I.A, Appendix B of the simplified modalities and procedures for small-scale CDM project activities states that if the energy generating equipment is transferred from another activity or if the existing equipment is transferred to another activity, leakage is to be considered.

In the case of the Project, the existing diesel fired generating units will remain in STAH piggery farm and will be used as backup. Therefore, there is no leakage associated with the Project activity.

For the methane recovery component, Type III.D, Appendix B of the simplified modalities and procedures for small-scale CDM project activities, does not require any leakage calculation.

Therefore, total project leakage is zero.

**Emission reduction**

Emission reductions are calculated as follows:

$$ER_{y,calculated} = BE_{STAH} + BE_{methane,y} - PE_y - Leakage$$

Deleted: $_y$ + $BE_{REE,y}$

Therefore:

$$ER_{y,calculated} = 312\ tCO_2e + 5{,}281\ tCO_2e - 0 - 0$$

Deleted: + 781 $tCO_2e$

$$ER_{y,calculated} = 5{,}593\ tCO_2e$$

Deleted: 6,374

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

| Crediting period (year) | Baseline emissions ($tCO_2e$) | | Project emissions ($tCO_2e$) | Emission reductions ($tCO_2e$) |
|---|---|---|---|---|
| | Electricity generation for STAH use | Methane recovery | | |
| 1 | 312 | 5,281 | 0 | 5,593 |
| 2 | 312 | 5,281 | 0 | 5,593 |
| 3 | 312 | 5,281 | 0 | 5,593 |
| 4 | 312 | 5,281 | 0 | 5,593 |
| 5 | 312 | 5,281 | 0 | 5,593 |
| 6 | 312 | 5,281 | 0 | 5,593 |
| 7 | 312 | 5,281 | 0 | 5,593 |
| TOTAL | | | | 39,151 |

Deleted: 6,374
Deleted: 6,374
Deleted: 6,374
Deleted: 6,374
Deleted: 6,374
Deleted: 6,374
Deleted: 43,837

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

### B.7.1 Data and parameters monitored:

Data monitored and required for verification and issuance will be kept for a minimum of two (2) years after the end of the crediting period or the last issuance of CERs for this project activity, whichever occurs later.

| **Data / Parameter:** | $E_{STAH,y}$ |
|---|---|
| Data unit: | kWh |
| Description: | Amount of electricity generated by the Project for STAH farm use |
| Source of data to be | Electricity meter |

| | |
|---|---|
| used: | |
| Value of data | 390,109 |
| Description of measurement methods and procedures to be applied: | The amount of electricity generated by the Project for STAH piggery farm use will be metered continuously using an electricity meter. |
| QA/QC procedures to be applied: | Electricity meter will be maintained and calibrated according to the manufacturer's standards. |
| Any comment: | |

| **Data / Parameter:** | $Q_{Ex,y}$ |
|---|---|
| Data unit: | kWh |
| Description: | Amount of electricity generated by the Project exported to outside users |
| Source of data to be used: | Electricity meter |
| Value of data | 600,529 |
| Description of measurement methods and procedures to be applied: | The amount of electricity generated by the Project exported to outside users will be metered continuously using an electricity meter. |
| QA/QC procedures to be applied: | Electricity meter will be maintained and calibrated according to the manufacturer's standards. |
| Any comment: | |

**Deleted:** $E_{REE}$

**Deleted:** sold to a local REE

**Deleted:** sold to local REE

| **Data / Parameter:** | $E_{gross,y}$ |
|---|---|
| Data unit: | kWh |
| Description: | Total amount of electricity generated by the Project. |
| Source of data to be used: | Electricity meter |
| Value of data | 1,314,000 |
| Description of measurement methods and procedures to be applied: | The amount of total electricity generated by the Project will be metered continuously using an electricity meter. |
| QA/QC procedures to be applied: | Electricity meter will be maintained and calibrated according to the manufacturer's standards. |
| Any comment: | This parameter shows the gross amount of electricity generated by the project activity. This value may be used to confirm actual electricity used for STAH farm's in-house operations and actual electricity sold to the REE. |

| **Data / Parameter:** | $P_{swine,y}$ |
|---|---|
| Data unit: | Swines |
| Description: | Swine population for the year y |
| Source of data to be used: | STAH records |
| Value of data | 14,774 |
| Description of | Swine population in the farm production sites are recorded everyday by STAH |

| | |
|---|---|
| measurement methods and procedures to be applied: | management. |
| QA/QC procedures to be applied: | Recording of the farm's swine population is conducted directly by STAH management to ensure accuracy. |
| Any comment: | Actual population in the year "y" will be monitored to determine the actual maximum potential methane emissions that the project will generate for that year. |

| **Data / Parameter:** | $\mathbf{ER_{y,calculated}}$ |
|---|---|
| Data unit: | $tCO_2e$ |
| Description: | Actual emission reduction achieved by the Project during the crediting period |
| Source of data to be used: | Calculated |
| Value of data | 5,593 |
| Description of measurement methods and procedures to be applied: | Calculated as:<br><br>$ER_{y,calculated} = (E_{STAH,y} * EF_{Diesel,STAH}) + + MD_y – PE – Leakage$<br><br>Where:<br>$E_{STAH,y}$ amount of electricity generated for STAH farm use in the year y<br>$EF_{Diesel,STAH}$ emission factor for diesel generator systems for STAH farm<br>$MD_y$ methane captured and destroyed by the project activity in the year y<br>$PE_y$ actual project emissions in the year y |
| QA/QC procedures to be applied: | Calculations to be reviewed by the CDM advisor to ensure correctness and accuracy. |
| Any comment: | |

**Deleted:** 6,374

**Deleted:** $(E_{REE,y} * EF_{Diesel,REE})$

**Deleted:** $E_{REE,y}$ amount of electricity generated sold to REE in the year y¶

**Deleted:** $EF_{Diesel,REE}$ emission factor for diesel generator systems for export to REE¶

| **Data / Parameter:** | $\mathbf{MD_y}$ |
|---|---|
| Data unit: | $tCO_2e$ |
| Description: | methane captured and destroyed by the project activity in the year y |
| Source of data to be used: | Calculated |
| Value of data | 5,281 |
| Description of measurement methods and procedures to be applied: | Calculated as:<br><br>$MD_y = BG_{burnt,,y} * w_{CH4,y} * D_{CH4,y} * FE * GWP_{CH4}$<br><br>Where:<br>$BG_{burnt,y}$ biogas flared or used as fuel in the year y<br>$w_{CH4,y}$ methane content in biogas in the year y<br>$D_{CH4}$ density of methane at the temperature and pressure of the biogas in the year y<br>FE flare efficiency in the year y, based on Flare Efficiency and Generator Combustion Efficiency outlined below<br>$GWP_{CH4}$ methane global warming potential |
| QA/QC procedures to | Calculations to be reviewed by the CDM advisor to ensure correctness and |

**Formatted:** Spanish (Spain-Modern Sort)

**Deleted:** used as fuel

**Deleted:** The volume of combusted biogas will be metered close to the biogas electricity generators, to ensure that any biogas leaking from the pipes or reactor are not included in the baseline emission calculation.

| | |
|---|---|
| be applied: | accuracy. |
| Any comment: | |

| | |
|---|---|
| **Data / Parameter:** | **Flare Efficiency** |
| Data unit: | % |
| Description: | The fraction of methane which is destroyed in the flare |
| Source of data to be used: | Default values, but based on monitoring of operation of flare |
| Value of data | 50% for biogas which is combusted in an open flare, as long as the temperature of the flare is monitored and found to be 500 degrees Centigrade or above (monitored under item $T_{flare}$ below). If the temperature of the flare falls below this figure, then the 0% default value shall be used. |
| Description of measurement methods and procedures to be applied: | N/A |
| QA/QC procedures to be applied: | |
| Any comment: | This parameter will only be monitored when there is surplus gas from the Project and a flare is installed. |

Formatted: Tabs: 252 pt, Left

| | |
|---|---|
| **Data / Parameter:** | **Generator Combustion Efficiency** |
| Data unit: | % |
| Description: | Combustion efficiency of the gas engines |
| Source of data to be used: | Methodological default value |
| Value of data | 90% |
| Description of measurement methods and procedures to be applied: | Continuous check of compliance with manufacturer's specification of the generator set will be carried out. 90% will be used as the combustion for ex-post CER estimates. Based on Approved Consolidated Methodology 0008, the efficiency of methane destroyed through power generation is 99.5%. As a conservative approach, the default value of 90% is used for this small scale project activity. |
| QA/QC procedures to be applied: | Maintenance of the generator set will be conducted based on manufacturer's instructions. |
| Any comment: | |

Formatted: Not Superscript/ Subscript

| | |
|---|---|
| **Data / Parameter:** | $\mathbf{T_{flare}}$ |
| Data unit: | Degrees Centigrade |
| Description: | Temperature of the flare |
| Source of data to be used: | Online measurement device |
| Value of data | 500 degrees Centigrade |
| Description of measurement methods and procedures to be applied: | An online temperature monitoring device will be installed to measure and record if the flare's temperature falls to below 500 degrees Centigrade. |

| | |
|---|---|
| QA/QC procedures to be applied: | The temperature measuring device will be calibrated according to manufacturer's instructions. |
| Any comment: | This parameter will only be monitored when there is surplus gas from the Project and a flare is installed. |

| **Data / Parameter:** | **$BG_{burnt,y}$** |
|---|---|
| Data unit: | $m^3$ |
| Description: | Amount of biogas recovered and combusted in the Project |
| Source of data to be used: | Calculated |
| Value of data | 577,426 |
| Description of measurement methods and procedures to be applied: | **$BG_{burnt,y} = BG_{burnt,GE,y} + BG_{burnt,F,y}$**<br><br>Where:<br>**$BG_{burnt,GE,y}$** biogas recovered and utilized in the electricity generating unit<br>**$BG_{burnt,F,y}$** biogas recovered and combusted in the flare |
| QA/QC procedures to be applied: | The gas flow meter will undergo maintenance and calibration subject to appropriate industry standards. |
| Any comment: | |

| **Data / Parameter:** | **$BG_{burnt,GE,y}$** |
|---|---|
| Data unit: | $m^3$ |
| Description: | Amount of biogas recovered and utilized in the electricity generating unit |
| Source of data to be used: | Gas flow meter |
| Value of data | 577,426 |
| Description of measurement methods and procedures to be applied: | The amount of biogas collected and sent to the generators will be continuously measured by a gas flow meter. The biogas will be metered close to the generating unit, so that any leakage of methane will be eliminated from the baseline emission calculation. The meter will be located such that any gas flared will not pass through it. |
| QA/QC procedures to be applied: | The gas flow meter will undergo maintenance and calibration subject to appropriate industry standards. |
| Any comment: | |

**Deleted:** the meter

| **Data / Parameter:** | **$BG_{burnt,F,y}$** |
|---|---|
| Data unit: | $m^3$ |
| Description: | Amount of biogas recovered and combusted in the flare |
| Source of data to be used: | Gas flow meter |
| Value of data | 0 |
| Description of measurement methods and procedures to be applied: | The amount of biogas combusted in the flare will be continuously measured by a gas flow meter. The biogas will be metered close to the flare, so that any leakage of methane will be eliminated from the baseline emission calculation. The meter will be located such that any gas combusted in the gas engine will not pass |

| | |
|---|---|
| | through the meter. |
| QA/QC procedures to be applied: | The gas flow meter will undergo maintenance and calibration subject to appropriate industry standards. |
| Any comment: | This parameter will only be monitored when there is surplus gas from the Project and a flare is installed. |

| **Data / Parameter:** | **$w_{CH4,y}$** |
|---|---|
| Data unit: | Fraction |
| Description: | Methane content in the biogas |
| Source of data to be used: | Regular sampling and measurement |
| Value of data | 0.65 |
| Description of measurement methods and procedures to be applied: | The fraction of methane in the biogas will be measured periodically by accredited gas analysis facilities. |
| QA/QC procedures to be applied: | Sampling will be carried out adhering to internationally recognized procedures. |
| Any comment: | |

| **Data / Parameter:** | **$D_{CH4,GE,y}$** |
|---|---|
| Data unit: | kg/m$^3$ |
| Description: | Density of methane at the temperature and pressure of the biogas utilised by the gas engine in the year y |
| Source of data to be used: | Calculated |
| Value of data | 0.67 |
| Description of measurement methods and procedures to be applied: | Calculated as: $D_{CH4} = \frac{P_{Biogas,GE,y} \bullet MW_{CH4}}{R \bullet T_{Biogas,GE,y}}$ Where: $P_{Biogas,GE,y}$ pressure of biogas in the year y, bar<br>$T_{Biogas,GE,y}$ temperature of biogas in the year y, K<br>R gas-law constant, 0.08314 bar.liter/mol.K[7]<br>$MW_{CH4}$ molecular weight of methane, 16.043 g/mol[8] |
| QA/QC procedures to be applied: | Calculations to be reviewed by the CDM advisor to ensure correctness and accuracy. |
| Any comment: | |

| **Data / Parameter:** | **$D_{CH4,F,y}$** |
|---|---|

Deleted: ,

Deleted:

Deleted: <<This formula will be amended in final draft>>

[7] Perry's Chemical Engineers Handbook 7th Edition, Table 1-9

[8] http://encyclopedia.airliquide.com/Encyclopedia.asp?GasID=41

| | |
|---|---|
| Data unit: | $kg/m^3$ |
| Description: | Density of methane at the temperature and pressure of the biogas combusted in the flare in the year y |
| Source of data to be used: | Calculated |
| Value of data | 0.67 |
| Description of measurement methods and procedures to be applied: | Calculated as: $D_{CH4} = \frac{P_{Biogas,F,y} \bullet MW_{CH4}}{R \bullet T_{Biogas,F,y}}$ Where: $P_{Biogas,F,y}$ pressure of biogas in the year y, bar<br>$T_{Biogas,F,y}$ temperature of biogas in the year y, K<br>R gas-law constant, 0.08314 bar.liter/mol.K[9]<br>$MW_{CH4}$ molecular weight of methane, 16.043 g/mol[10] |
| QA/QC procedures to be applied: | Calculations to be reviewed by the CDM advisor to ensure correctness and accuracy. |
| Any comment: | |

Formatted: (Asian) Japanese, Lowered by 16 pt

Deleted: <<This formula will be amended in final draft>>

| **Data / Parameter:** | **$T_{Biogas,GE,y}$** |
|---|---|
| Data unit: | K |
| Description: | Temperature of the biogas utilised by the gas engines in the year y |
| Source of data to be used: | Temperature gauge |
| Value of data | To be measured |
| Description of measurement methods and procedures to be applied: | The temperature of the biogas will be measured to determine the density of methane combusted. |
| QA/QC procedures to be applied: | Temperature gauge will be maintained and calibrated according to the manufacturer's standards. |
| Any comment: | |

| **Data / Parameter:** | **$T_{Biogas,F,y}$** |
|---|---|
| Data unit: | K |
| Description: | Temperature of the biogas combusted in the open flare in the year y |
| Source of data to be used: | Temperature gauge |
| Value of data | To be measured |
| Description of measurement methods | The temperature of the biogas will be measured to determine the density of methane combusted. |

[9] Perry's Chemical Engineers Handbook 7th Edition, Table 1-9

[10] http://encyclopedia.airliquide.com/Encyclopedia.asp?GasID=41

| | |
|---|---|
| and procedures to be applied: | |
| QA/QC procedures to be applied: | Temperature gauge will be maintained and calibrated according to the manufacturer's standards. |
| Any comment: | |

| **Data / Parameter:** | **$P_{Biogas,GE,y}$** |
|---|---|
| Data unit: | bar |
| Description: | Pressure of the biogas utilised by the gas engines in the year y |
| Source of data to be used: | Pressure gauge |
| Value of data | To be measured |
| Description of measurement methods and procedures to be applied: | The pressure of the biogas will be measured to determine the density of methane combusted. |
| QA/QC procedures to be applied: | Pressure gauge will be maintained and calibrated according to the manufacturer's standards. |
| Any comment: | |

| **Data / Parameter:** | **$P_{Biogas,F,y}$** |
|---|---|
| Data unit: | bar |
| Description: | Pressure of the biogas combusted in the open flare in the year y |
| Source of data to be used: | Pressure gauge |
| Value of data | To be measured |
| Description of measurement methods and procedures to be applied: | The pressure of the biogas will be measured to determine the density of methane combusted. |
| QA/QC procedures to be applied: | Pressure gauge will be maintained and calibrated according to the manufacturer's standards. |
| Any comment: | |

**Formatted:** Indent: First line: 0 pt

| **Data / Parameter:** | **$FF_j$** |
|---|---|
| Data unit: | TJ |
| Description: | Amount of fossil fuel "j" consumed |
| Source of data to be used: | Manual measurement |
| Value of data | 0 |
| Description of measurement methods and procedures to be applied: | |
| QA/QC procedures to | |

| | |
|---|---|
| be applied: | |
| Any comment: | The existing diesel generators will be used should there be lack of biogas production or problems with the gas engines. In this case, diesel used for the existing generators is outside the project boundary. For contingency purposes, the volume of any fossil fuel use will be manually measured. |

| **Data / Parameter:** | **Final Sludge Handling** |
|---|---|
| Data unit: | |
| Description: | Monitoring of the final sludge to ensure that proper soil application is applied and does not result in methane emissions. |
| Source of data to be used: | Sales receipt of final sludge collected. |
| Value of data | |
| Description of measurement methods and procedures to be applied: | As instructed in paragraph 16 of AMS-III.D, the proper soil application not resulting in methane emissions of the final sludge must be monitored. STAH management will sell the final sludge extracted from the covered anaerobic bio-digester to nearby communities to be used as fertilizer. |
| QA/QC procedures to be applied: | Sales receipt of the final sludge collected will confirm that the final sludge will be used as fertilizer, thereby not result in methane emissions. |
| Any comment: | It is expected that the covered anaerobic bio-digestion system will require excess sludge extraction every 2 to 3 years. Selling the final sludge to local villagers for soil application ensures that the sludge will be handled aerobically, instead of being disposed of in landfills which results in methane emissions. |

| **Data / Parameter:** | **On Site Inspection** |
|---|---|
| Data unit: | |
| Description: | On site inspections for each individual farm included in the project boundary where the project activity is implemented for each verification period. |
| Source of data to be used: | |
| Value of data | |
| Description of measurement methods and procedures to be applied: | As instructed in paragraph 17 of AMS-III.D, The monitoring plan should include on site inspections for each individual farm included in the project boundary where the project activity is implemented for each verification period. |
| QA/QC procedures to be applied: | |
| Any comment: | For the Project's case, there is only one farm in the project boundary where the project activity is implemented. Therefore, on site inspection will only be in Samrong Thom Animal Husbandry (STAH) piggery farm. |

**B.7.2 Description of the monitoring plan:**

STAH will form an operational and management team, which will be responsible for carrying out all monitoring functions as prescribed in the Monitoring Plan. This team composes of a general manager, supervisor and operators. The operators, who are under the supervisor, will be assigned for monitoring of the parameters on a timely basis as well as recording and archiving data in an orderly manner.

Monitoring reports will be forwarded to and reviewed by the general manager on a weekly basis in order to ensure the Project follows the requirements of the monitoring plan.

Data monitored and required for verification and issuance will be kept for a minimum of two (2) years after the end of the crediting period or the last issuance of CERs for this project activity, whichever occurs later. Data archived will also be verified regularly by the DOE. The performance of the Project will be reviewed and analyzed by the CDM consultant on a regular basis.

The figure below outlines the management and operational structure that STAH will implement to monitor emission reductions and any leakage effects generated by the Project.

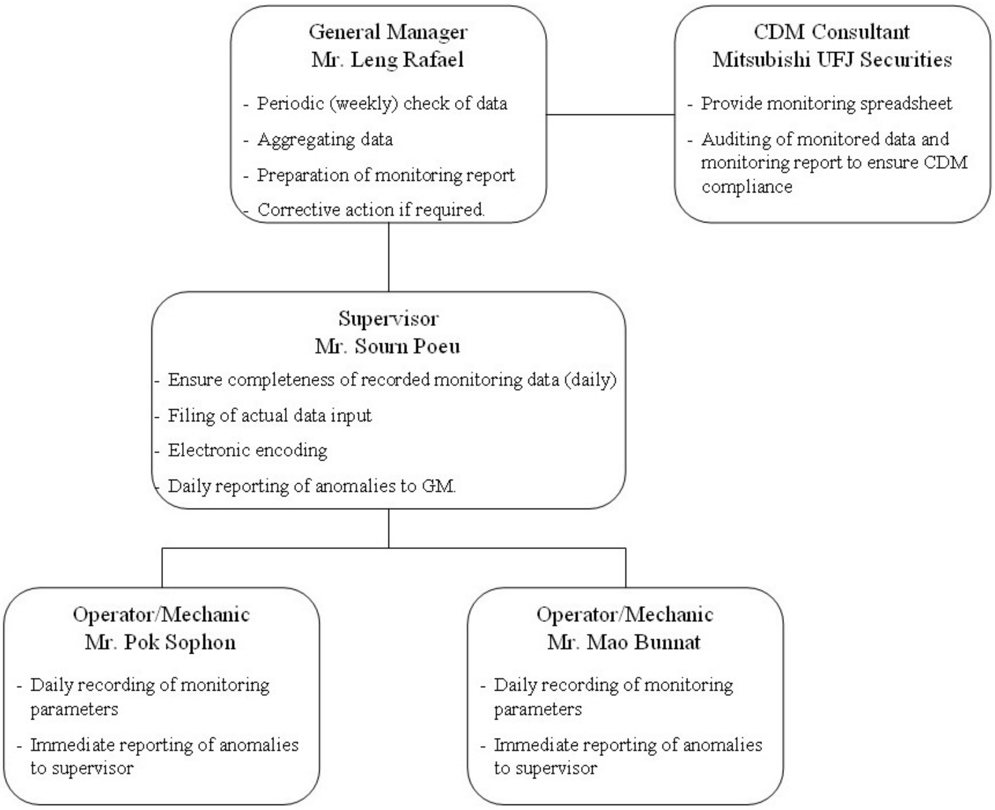



Figure 6 – Management and operational structure for monitoring

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

**Date of completing the final draft of this baseline section (DD/MM/YYYY):**

14/09/2008

Deleted: 06

Deleted: 11

Deleted: 2007

**Name of person/entity determining the baseline:**

Raymond Caguioa / Matthew Setterfield
Clean Energy Finance Committee, Mitsubishi UFJ Securities Co., Ltd.
Marunouchi Building, 2-4-1 Marunouchi, Chiyoda-ku, Tokyo 100-6317, Japan
Tel: (81 3) 6213-2859 Fax: (81 3) 6213-6175
Email: setterfield-matthew@sc.mufg.jp

Mitsubishi UFJ Securities Co., Ltd. is the CDM advisor to the Project and is also a project participant. The contact details of the above entity determining the baseline is listed in Annex I.

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

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

Formatted

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

15/04/2007

The starting date of the project activity is here defined as the date on which the excavation works began.

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

Minimum of 21 years

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

The project activity will use a renewable crediting period.

#### C.2.1. Renewable crediting period

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

15/12/2007

The starting date of the first crediting period is here defined as the earliest date on which the commercial operation may begin. Should operation be delayed, the starting date of the first crediting period will be delayed accordingly.

The starting date of the crediting period will not start prior to the date of registration.

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

7 years

**C.2.2. Fixed crediting period:**

**C.2.2.1. Starting date:**

Not applicable

**C.2.2.2. Length:**

Not applicable

## SECTION D. Environmental impacts

**D.1. If required by the host Party, documentation on the analysis of the environmental impacts of the project activity:**

An Environmental Impact Assessment (EIA) is not required for a power generation project of less than 5MW in capacity except for hydropower project for which EIA is required if the generation capacity is greater than 1MW in Cambodia. Thus, the proposed Project is under the legal limit for submitting an Environmental Impact Assessment.

Aside from medium to large-scale hydroelectricity power plants, it is generally accepted that renewable energies have fewer negative impacts on human and natural systems than fossil-fuel based technologies. Though not required by the Cambodian legislation, from both ethical and professional perspectives, an environmental due diligence review was conducted, to ensure that the Project has limited or non-existent negative social and environmental impacts:

| Risks | Mitigation Measures |
|---|---|
| Emissions of gaseous pollutants | ▪ The methane recovery and combustion installations will be located in open air with only the protection of a roof. This will limit toxic and explosion hazards associated with the concentration of gaseous pollutants in more confined areas.<br>▪ Periodic checks of the installations for leakages need to be performed by system operators and safety officers.<br>▪ The combustion engine must be periodically fine tuned so as to allow for the complete combustion of methane, thus limiting emissions of gaseous pollutants. |
| Noise from Generation Activities | ▪ The installations are insulated to fully comply with existing noise generation standards. In addition, operators will be required to wear personal protection equipment, including earplugs. |
| Work accidents resulting from operation and maintenance activities | ▪ Workers will need to undergo a comprehensive training programme in order to operate the installations efficiently and safely.<br>▪ Operations will follow accepted international industrial safety standards. This will include the designation of safety officers, and the formulation and adoption of adapted safety procedures for plant operations and maintenance. |

| | |
|---|---|
| Bad odour from animal waste storage | ▪ Covering the anaerobic lagoons for methane capture is expected to eliminate much of the unpleasant odours. |

**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:**

No significant environmental impacts are expected to result from the Project. In fact, the project will contribute to environmental preservation by reducing GHG emissions, noxious odors from the lagoon and fuel oil combustion.

## SECTION E. Stakeholders' comments

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

A local stakeholders' meeting has been conducted by Samrong Thom Animal Husbandry (STAH) on the 29th of April 2007. The meeting took place in STAH piggery farm compound.

Total of 31 participants, composed of representatives from the Samrong Thom commune, other neighbouring communes, local school and village residents among others, attended the meeting.

The following are brief descriptions of what was presented during the meeting:

1. Project developer statement
    a. Brief description of the STAH farm
    b. Brief description of the Project
2. Presentation of the Project
    a. Background of STAH farm
    b. Background of the Project
    c. Description of the technology used
    d. Explanation of how the Project contributes to the environment
3. Question and answer session
4. Visit to the farm

**E.2. Summary of the comments received:**

Questions were asked regarding:

- Handling of piggery wastes
- Unpleasant smell from lagoon
- Sludge handling
- Operation and maintenance measures

All the questions were answered by STAH and accepted by the attendees. The detailed questions, comments and responses were recorded in the minutes of the meeting.

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

The comments received from the attendees are all in favour of the proposed project and no negative comments have been received. Below is the summary of the question and answer session conducted during the stakeholders' consultation meeting.

| | COMMENTS / QUESTIONS | RESPONSES / ACTIONS TO TAKE |
|---|---|---|
| **Mr. TOURN Phan**<br>**School Director** | What is the size of the lagoon?<br><br>Why do you develop such a big lagoon? | The lagoon's size is : 143m x 40m x 4,5m<br><br>Because it's the necessary size to provide a generator of 200 kW. |
| **Mr. TEP Chhourn**<br>**Commune Official** | How often do you pump the piggery wastes to the lagoon? | Everyday, we must pump the sludge to the main lagoon. In fact, the manure will be temporary collected in a small lagoon in order to filter some unwanted objects like plastic bags, bottles, etc. After this operation, the sludge will be daily transfer to the principal manure. |
| **Ms. BUT Vanna**<br>**Commune Official** | How much unpleasant smell can you reduce? | As I told to Mr. TEP before, the piggery wastes will be daily pumped to the lagoon. So undesirable smell will be reduced to minimum. |
| **Mr. KUCH Dim** | When do you take out the sludge from the lagoon?<br><br>Will you sell the residue of the manure? | We will pump it out every 2-3 years through the outlet part<br><br>The farm doesn't need it. The residue of the manure will keep drying and may be sold. |
| **Mr. OM Chhin**<br>**Village Official** | Why don't you start the project before? | In order to develop and to invest in this project, some companies contacted us a few years ago. As we hadn't enough cash-flows, we relied on their decisions to invest or not. After waited for two years, we had unfortunately no real investment decision from these companies.<br>The swine farm started with 100 sows only at the beginning. Today, the farm's pig population is around 15 000 heads and the dilemma of the piggery wastes becomes more and more important in terms of environment aspects. So now, we take the risk to invest by ourselves. As our cash-flows are insufficient to finance this project, we decided to get a bank loan. |
| | How do you cover the lagoon? | The lagoon is covered by High-Density |

| | | |
|---|---|---|
| **Mr. NHEM Kny Village Resident Association** | In case of leak from the lagoon, what will you do?What are the nega results for the village? | PolyEthylene (HDPE)<br><br>We will repair it promptly because the farm is dependent on electricity.<br>There are minor impacts because the village is about 500 meters from the lagoon. |

**Annex 1**

**CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY**

| | |
|---|---|
| Organization: | Samrong Thom Animal Husbandry |
| Street/P.O.Box: | National Road #1 |
| Building: | |
| City: | Phum Prek Treng, Khum San Rong Thom, Srok Kean Svay |
| State/Region: | Kandal Province |
| Postfix/ZIP: | |
| Country: | Cambodia |
| Telephone: | +85-23-211-709 |
| FAX: | +85-23-213-946 |
| E-Mail: | |
| URL: | |
| Represented by: | |
| Title: | |
| Salutation: | Mr. |
| Last Name: | Leng |
| Middle Name: | |
| First Name: | Sunrafael |
| Department: | |
| Mobile: | +85-511-564-173 |
| Direct FAX: | |
| Direct tel: | |
| Personal E-Mail: | leng.rafael@hotmail.com |

| | |
|---|---|
| Organization: | Mitsubishi UFJ Securities Co., Ltd. (CDM Advisor) |
| Street/P.O.Box: | 2-4-1 Marunouchi |
| Building: | Marunouchi Building |
| City: | Chiyoda-ku |
| State/Region: | Tokyo |
| Postfix/ZIP: | 100-6317 |
| Country: | Japan |
| Telephone: | +813-6213-2859 |
| FAX: | +813-6213-6175 |
| E-Mail: | setterfield-matthew@sc.mufg.jp |
| URL: | http://www.sc.mufg.jp/english/e_cefc/index.html |
| Represented by: | |
| Title: | CDM Consultant |
| Salutation: | Mr. |
| Last Name: | Setterfield |
| Middle Name: | |
| First Name: | Matthew |
| Department: | Clean Energy Finance Committee |
| Mobile: | |

| | |
|---|---|
| Direct FAX: | +813-6213-6175 |
| Direct tel: | +813-6213-2859 |
| Personal E-Mail: | setterfield-matthew@sc.mufg.jp |

## Annex 2

**INFORMATION REGARDING PUBLIC FUNDING**

Not applicable

## Annex 3

## BASELINE INFORMATION

Spreadsheet used for baseline calculations:

| | | | |
|---|---|---|---|
| **Electricity for STAH use** | | | |
| | | | |
| Based on historic electricity consumption calculated from fuel consumption in FS | | | |
| 390,109 | | kWh/yr | annual power for in-house use |
| 0.8 | | kgCO2/kWh | default value, ams-i.d |
| | | | |
| **312** | | tCO2/yr | Baseline emission |
| | | | |
| | | | |
| **AMS-III.D. version 12** | | | |
| | | | |
| Baseline | | | |
| | | | |
| 17.02068 | EF | kgCH4/animal/yr | CH4 emission factor for swine |
| 0.3 | VS | kgVS/animal/day | default |
| 0.29 | Bo | m3CH4/kgVS | |
| 0.67 | | kgCH4/m3CH4 | conversion factor |
| 0.8 | MCF | fraction | |
| 1 | MS | fraction | |
| 27.5 | | degC | average annual temperature |
| 14,774 | | animals | swine population |
| | | | |
| **5,281** | | tCO2/yr | baseline emissions |
| | | | |
| | | | |
| Current electricity consumption | | | |
| | | | |
| 288,000 | | kWh/yr | Farm consumption |
| 150 | | Hp | Extruder consumption |
| 0.746 | | kW/Hp | conversion factor |
| 2.5 | | hr/day | Extruder operation hours |
| 912.5 | | hr/yr | Extruder operation hours per year |
| 102,109 | | kWh/yr | Extruder consumption per year |
| 390,109 | | kWh/yr | Total Farm consumption |
| | | | |
| Total electricity generation | | | |
| | | | |
| 200 | | kW | installed capacity |
| 7,300 | | hours | annual operation hours |

Formatted Table

... [3]

| | | | |
|---|---|---|---|
| 1,314,000 | kWh/yr | annual generation @ 10% parasitic load | |
| 390,109 | kWh/yr | Total Farm consumption | |
| 923,891 | kWh/yr | excess electricity available | |
| 0.65 | | load factor including distribution losses | |
| 600,529 | kWh/yr | electricity sale | |
| 990,638 | kWh/yr | total projected electricity generation | |
| | | | |
| Specific fuel consumption | | | |
| | | | |
| 577,426 | m3/yr | volume biogas collected and utilized | |
| | | | |
| 50.4 | GJ/t | net calorific value of biogas | |
| | | | |
| 0.65 | | methane content in biogas | data from supplier specifications |
| 277.7778 | kWh/GJ | conversion factor | |
| 0.38 | | electrical efficiency of engine | data from supplier specifications |
| | | | |
| 387 | t/yr | biogas produce | |
| 2,058,179 | kWh/yr | potential energy generation | |
| | | | |
| **0.280552** | **m3 biogas/kWh** | | |
| **280.55** | **m3 biogas/MWh** | | |

Summary of calculations:

| Crediting period (year) | Baseline emissions ($tCO_2e$) I.A | Baseline emissions ($tCO_2e$) III.D | Project emissions ($tCO_2e$) | Emission reductions ($tCO_2e$) |
|---|---|---|---|---|
| 1 | 312 | 5,281 | 0 | 5,593 |
| 2 | 312 | 5,281 | 0 | 5,593 |
| 3 | 312 | 5,281 | 0 | 5,593 |
| 4 | 312 | 5,281 | 0 | 5,593 |
| 5 | 312 | 5,281 | 0 | 5,593 |
| 6 | 312 | 5,281 | 0 | 5,593 |
| 7 | 312 | 5,281 | 0 | 5,593 |
| TOTAL | | | | 39,151 |
| Average | | | | 5,593 |

Temperature profile of Phnom Phen:

http://www.bbc.co.uk/weather/world/city_guides/results.shtml?tt=TT002520

## Phnom Penh, Cambodia

| Month | Average Sunlight (hours) | Temperature | | | | Discomfort from heat and humidity | Relative humidity | | Average Precipitation (mm) | Wet Days (+0.25 mm) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Average | | Record | | | | | | |
| | | Min | Max | Min | Max | | am | pm | | |
| Jan | 9 | 21 | 31 | 14 | 35 | High | 71 | - | 7 | 1 |
| Feb | 9 | 22 | 32 | 15 | 37 | High | 71 | - | 10 | 1 |
| March | 9 | 23 | 34 | 19 | 39 | Extreme | 70 | - | 40 | 3 |
| April | 8 | 24 | 35 | 20 | 41 | Extreme | 73 | - | 77 | 6 |
| May | 7 | 24 | 34 | 21 | 38 | Extreme | 81 | - | 134 | 14 |
| June | 6 | 24 | 33 | 21 | 38 | Extreme | 81 | - | 155 | 15 |
| July | 6 | 24 | 32 | 20 | 37 | Extreme | 83 | - | 171 | 16 |
| Aug | 6 | 26 | 32 | 22 | 36 | Extreme | 83 | - | 160 | 16 |
| Sept | 5 | 25 | 31 | 22 | 36 | Extreme | 85 | - | 224 | 19 |
| Oct | 7 | 24 | 30 | 21 | 34 | High | 83 | - | 257 | 17 |
| Nov | 8 | 23 | 30 | 18 | 34 | High | 79 | - | 127 | 9 |
| Dec | 9 | 22 | 30 | 14 | 35 | High | 74 | - | 45 | 4 |
| Average | | 23.5 | 32 | | | | | | | |
| Total Average | | 27.75 | | | | | | | | |

**Density of methane**

http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=197

| | |
|---|---|
| 6.67E-04 | g/cm3 |
| **0.000667** | **t/m3** |

http://encyclopedia.airliquide.com/Encyclopedia.asp?GasID=41

| | | |
|---|---|---|
| 0.68 | kg/m3 | gas density at 1.013 bar and 15 C |
| 1.819 | kg/m3 | gas density at 1.013 bar at boiling point |
| 16.043 | g/mol | molecular weight |

$n = pV/RT$

**STAH Pig Population in 2006**

| | |
|---|---|
| Jan | 14,017 |
| Feb | 13,864 |
| Mar | 13,927 |
| Apr | 14,187 |
| May | 14,373 |
| Jun | 15,021 |
| Jul | 15,127 |

| | |
|---|---|
| Aug | 15,209 |
| Sep | 15,362 |
| Oct | 15,420 |
| Nov | 15,391 |
| Dec | 15,394 |
| AVERAGE | 14,774 |

## Annex 4

### MONITORING INFORMATION

The necessary information is provided in Section B above.

- - - - -

| **Page 16: [1] Deleted** | **Mon** | **16.09.2008 14:54:00** |
|---|---|---|

| | |
|---|---|
| ~~**Data / Parameter:**~~ | ~~**$EF_{Diesel,REE}$**~~ |
| ~~Data unit:~~ | ~~$kgCO_2e/kWh$~~ |
| ~~Description:~~ | ~~Emission factor for diesel generator systems displaced by REE~~ |
| ~~Source of data used:~~ | ~~AMS-I.D, Table I.D.1~~ |
| ~~Value applied:~~ | ~~1.3~~ |
| ~~Justification of the choice of data or description of measurement methods and procedures actually applied :~~ | ~~Value applied as per instructions in the methodology. In the baseline power is sourced from battery charging stations which use diesel gensets of about 11kW capacities. The emission factor of 1.3$kgCO_2e/kWh$ from Table 1.D.1 in AMS-I.D is selected as a conservative value.~~ |
| ~~Any comment:~~ | |

| **Page 20: [2] Deleted** | **14.09.2008 07:20:00** |
|---|---|

*For export to REE*

Similar to the calculation of baseline emission from electricity generation for the use of STAH piggery farm, the calculation of baseline emission from supplying excess electricity to an REE is conducted according to paragraph 7, option (b) of AMS-I.A:

$$E_{REE,y} = \sum_i O_{i,y} / (1 - l)$$

Where:

$E_{REE,y}$ annual energy baseline in kWh in the year "y" for export to REE

Therefore:

| | | | | |
|---|---|---|---|---|
| Energy baseline, $E_{REE,y}$ (kWh/year) | = | Annual output, $O_{i,y}$ (kWh/year) | / | (1-0) |
| Energy baseline, $E_{REE,y}$ (kWh/year) | = | 390,109 (kWh/year) | / | (1-0) |
| Energy baseline, $E_{REE,y}$ (kWh/year) | = | 600,529 | | |

The Rural Electricity Enterprise, to which the electricity will be sold, will distribute the electricity to nearby communities. These communities currently rely on rechargeable batteries from battery charging shops which use diesel gensets with about 11kW capacities. The emission factor of 1.3$kgCO_2e/kWh$ from Table 1.D.1 in AMS-I.D is selected as a conservative value. In fact, the emission factor in terms of the final electricity output of the batteries, would be many times higher than this, as significant amounts of energy are lost in the battery-charging process.

Therefore:

| | | | | | | |
|---|---|---|---|---|---|---|
| Baseline emission $BE_{REE,y}$ ($tCO_2e$/year) | = | Energy baseline, $E_{REE,y}$ (kWh/year) | x | Emission factor for diesel generation | x | 1 $tCO_2e$ / 1,000 $kgCO_2e$ |

| | | | | |
|---|---|---|---|---|
| | | | | system, $EF_{Diesel,REE}$ ($kgCO_2e/kWh$) | | |
| Baseline emission $BE_{REE,y}$ ($tCO_2e/year$) | = | 600,529 (kWh/year) | x | 1.3 ($kgCO_2e/kWh$) | x | 1 $tCO_2e$ / 1,000 $kgCO_2e$ |
| Baseline emission $BE_{REE,y}$ ($tCO_2e/year$) | = | 781 | | | | |

**Page 43: [3] Deleted** **Mon** **16.09.2008 15:19:00**

| | | | | |
|---|---|---|---|---|
| | | | | |
| ~~**Electricity for export**~~ | | | | |
| | | | | |
| ~~600,529~~ | | ~~kWh/yr~~ | ~~annual power for export~~ | |
| ~~1.3~~ | | ~~kgCO2/kWh~~ | ~~default value, ams-i.d~~ | |
| | | | | |
| ~~**781**~~ | | ~~tCO2/yr~~ | ~~Baseline emission~~ | |
| | | | | |