Programme design document form for small-scale CDM programmes of activities

(Version 05.0)

Complete this form in accordance with the Attachment "Instructions for filling out the programme design document form for small-scale CDM programmes of activities" at the end of this form.

PROGRAMME DESIGN DOCUMENT (PoA-DD)	
Title of the PoA	Thailand Small Scale Livestock Waste Management Program
Version number of the PoA-DD	14
Completion date of the PoA-DD	18/08/2016
Coordinating/ managing entity	Energy Research and Development Institute – Nakornping of Chiang Mai University (ERDI)
Host Party(ies)	Thailand
Applied methodology(ies) and, where applicable, applied standardized baseline(s)	AMS-III.D. Methane recovery in animal manure management systems --- Version 18.0
Sectoral scope(s) linked to the applied methodology(ies)	13 : Waste handling and disposal

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PART I. Programme of activities (PoA)

SECTION A. General description of PoA

A.1. Title of the PoA

Thailand Small Scale Livestock Waste Management Program
Version: 14
Date of completion: 18/08/2016

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A.2. Purpose and general description of the PoA

PoA description

Thailand Small Scale Livestock Waste Management Program (hereafter, the "Project") is developed by Energy Research and Development Institute – Nakornping of Chiang Mai University (ERDI). The proposed activity will reduce greenhouse gas emissions from piggeries manure by converting anaerobic lagoons to flow closed anaerobic treatment digesters with biogas capture and power generation in Thailand. ERDI will provide complete CDM services to the participating farms as well as additional technical support for waste management system operation and monitoring. These technical capacities provided by ERDI will ensure long-term sustainability of the project activity.

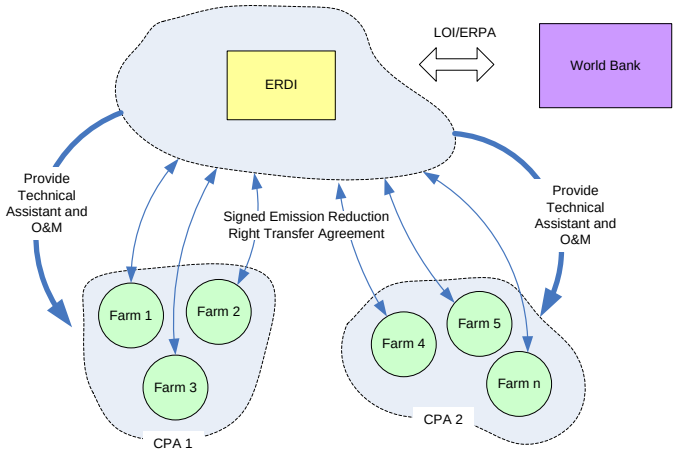
The treatment of livestock manure by way of anaerobic digester processes leads to the production of a biogas consisting of 60% methane (CH_4). Currently most farms in Thailand employ normal scraping and hose-down cleaning of the animal waste with a series of anaerobic lagoons within the farms premises. This waste material is left to decay in the individual facility's anaerobic lagoon system, producing significant amounts of methane that is emitted directly to the atmosphere. These current livestock waste management practices contribute to significant air (odour) and water pollution in the areas close to the farms. The project will apply anaerobic digesters which will capture the biogas and use it to generate electricity for on farm consumption or sale to national grid.

In addition to improving the local environment quality, the project will also deliver local community benefits related to the creation of new jobs during the construction, operation and maintenance stages of the livestock wastewater management system and to the utilization of methane gas (CH_4) as renewable energy resource for the farms. The project activities can also be replicated in other farms around the country which will lead to environmental awareness related to livestock waste management, renewable energy, and climate change.

1. General operating and implementing framework of PoA
The PoA aims to improve the livestock waste management practice, reduce GHG emissions, and take advantage of the captured renewable energy of piggeries farms in different areas of Thailand. The project activity is to convert anaerobic lagoons to an enclosed system which will capture and utilize methane to generate electricity for consumption within the participating farms.

Energy Research and Development Institute - Nakornping of Chiang Mai University (ERDI), is serving as coordinating/managing entity of the PoA. ERDI has overall responsibility for PoA and subsequent CPAs preparation and implementation. Operation and monitoring of each participating farm will be supervised by ERDI. Figure A.2.1 illustrated the institutional arrangement for the POA and CPA. ERDI is an excellence centre in energy-related fields that has been acknowledged at national and international levels. ERDI provides technologies and professional consulting services in energy conservation, renewable energy and other related engineering prospects for government and private organizations.

Figure A.2.1 Institutional Arrangement



Contribution to Sustainable Development

The project supports Thailand's sustainable development strategy in the following ways:

1) Effectively reducing CH_4 emissions from animal wastes. The project activity consists of an advanced improvement from the common practice of livestock waste treatment, reducing CH_4 and N_2O emissions from livestock waste through biogas digesters with methane capture and utilization;
2) Improving the local environment and human health. Properly handling of large quantities of animal waste is critical to protecting human health and the environmental quality. The advanced livestock waste management system to be employed will reduce the nuisance of odors and wastewater, benefiting both farmers' and children's health;
3) Creating job opportunities and increasing farmers' income. This project activity will increase local employment for skilled labor during production, installation, operation, and maintenance of the anaerobic digestion and electricity generation equipment and systems;
4) Localizing energy production. The project will diversify the source of the energy supply through biogas production and biogas-based power generation. The effort will substitute local energy for electricity from the grid which relies mainly on fossil fuel;
5) Establishing a positive model of swine waste management practice for other livestock operations. The project activity will apply new, advanced, and environmentally friendly technologies in treating swine wastes and associated utilization, which can be replicated on other livestock farms, which will dramatically reduce livestock-related GHG emissions.

2. Policy/measure or stated goal of the PoA

The PoA is addressing three important policies in Thailand.

- Notification of the Ministry of Natural Resources and Environment, Effluent Standard for Pig Farm[1] dated November 7, B.E. 2548 (2005) requires effluent discharges into watercourses from swine farms to have total suspended solids of below 150 mg/L and BOD of less than 60 mg/L.

[1] published in the Royal Government Gazette, Vol. 122 Part 125 D, dated December 29, B.E. 2548 (2005)

The Notification has been announced since 2005, there are limited numbers of pig farms that able to meet the set standard through the application of advance anaerobic wastewater treatment proposed by the POA.

- Energy Development plan for B.E. 2551-2565 (2008-2022)[2]. The objective of the plan is to increase the percentage share of renewable energy from 6.4% in 2008 to 20% in 2022 with various measures including the promotion of energy from agriculture waste.

  The POA will provide strong support for the policy by providing incentives as well as technical assistance for the participating farm to generate renewable energy in line with the policy.

- Thailand Climate Change Strategy (2007-2011)[3]: Greenhouse gas mitigation through development of renewable energy from waste material.

3. Confirmation that the proposed PoA is a voluntary action by the coordinating/managing entity

The proposed PoA is a voluntary action by the coordinating/managing entity. All farms participate in the PoA voluntarily. The stated policies encourage the farms to adopt clean technologies for waste management and use alternative energy while reducing greenhouse gases. These actions are not mandatory.

A.3. CMEs and participants of PoA

1. ERDI is the coordinating/managing entity of the PoA and the entity which communicates with the Board.
2. Project participants being registered in relation to the PoA. Project participants may or may not be involved in one of the CPAs related to the PoA. The detail of the project participants are listed in table A.3.1. below and in Annex I.

A.4. Party(ies)

Name of Party involved (host) indicates host Party	Private and/or public entity(ies) project participants, CME (as applicable)	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
Thailand (host)	Energy Research and Development Institute – Nakornping of Chiang Mai University	No
Portugal	International Bank for Reconstruction and Development as Trustee of the Carbon Fund for Europe ; Government of Portugal – Portuguese Carbon Fund	Yes

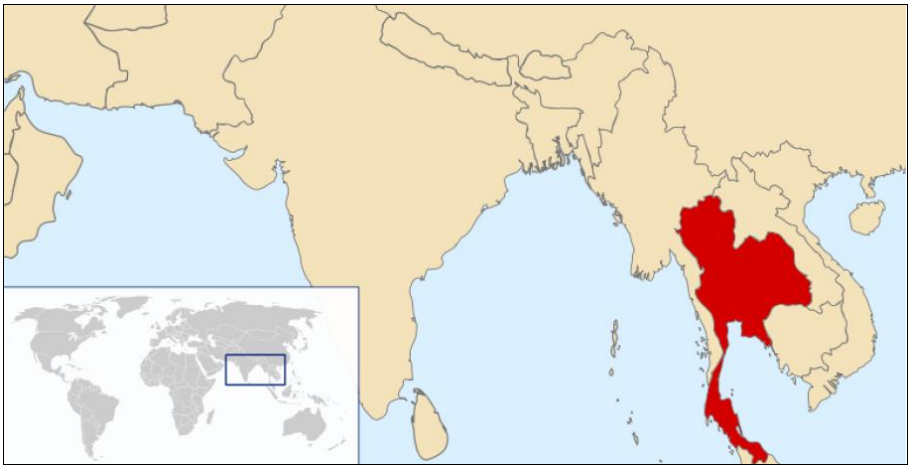
Contact information for each party is provided in Annex I

[2] Announced by Department of Alternative Energy Development and Efficiency (DEDE) on 7 June 2007 http://www.dede.go.th/dede/fileadmin/upload/nov50/mar52/REDP_present.pdf

[3] http://www.onep.go.th/index.php?option=com_content&task=view&id=503

A.5. Physical/ Geographical boundary of the PoA

The boundary for the PoA is Thailand, and the Programme of Activities covers pig farms in Thailand. All small-scale CDM programme activities (SSC-CPA) included in the PoA will be implemented in Thailand.



A.6. Technologies/measures

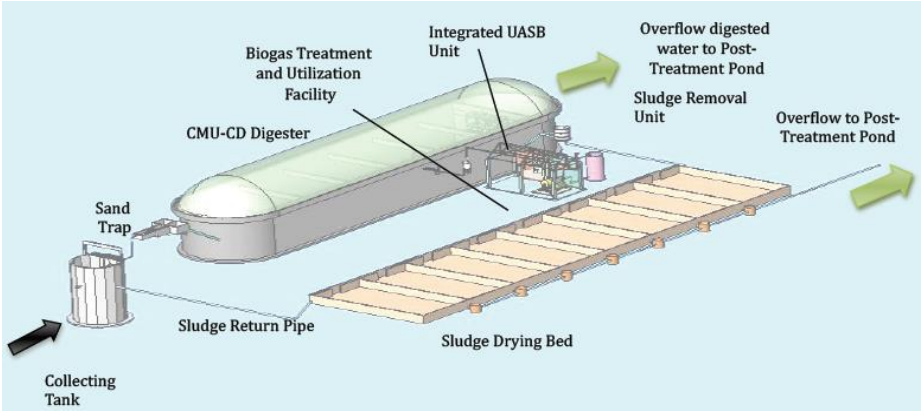
The technology to be employed by the SSC-CPA is anaerobic wastewater treatment technologies. Anaerobic digestion technologies capture methane for use in energy applications and provide other environmental benefits related to water and air quality, human health, and greenhouse gas reduction. Waste collection from all farms described in this project are collected daily or every other day by hose flushing all material through a series of collection channels. These channels currently connect to anaerobic lagoons at these farms. The project plans to connect these channels to (a) a screen, (b) a sand trap, and (c) a collection tank. The purpose of the screen and sand trap is to remove the undesirable inert material which could accumulate in the digester causing problems over time. The collection tank is to collect all separated waste material at one central point to be then pumped to the anaerobic digester following a daily digester charging schedule.

From the collection tank, waste is transferred to the anaerobic digester. This project plans to install anaerobic digestion technology designed by Energy Research and Development Institute (ERDI). The schematic design of the technology is illustrated in figure A.4.2.1. The targeted system size is from 300 m^3 per farm or about 2,000 pig heads to 20,000 m^3 per farm or about 150,000 pig heads.

The digestion tank first receives the separated waste material from the collection tank. The digestion tank serves three purposes (a) it initiates the anaerobic process and establishes methanogenic activity; (b) it allows solids settling, which increases the Solids Retention Time (SRT) to about 40 days; and (c) the extended SRT maximizes gas production while allowing the remaining Chemical Oxygen Demand (COD) in the solid fraction to be desorbed into the liquid phase.

After the digestion tank reduces solids content and concentrates remaining COD in the liquid phase, the liquids flow into a high rate up-flow reactor. This type of reactor requires dilute wastes and can tolerate fine solids which form the biomass where the majority of microbial populations operate and convert the remaining COD into methane.

Figure A.4.2.1 Schematic Design of ERDI anaerobic technology



Electricity energy will be generated by combusting the biogas produced from the digester. Hydrogen sulfide (H_2S) will be removed with a biological scrubber to reduce the corrosive effects on the engines critical parts when combusted. Biological scrubbers contain sulfur oxidizing bacteria to remove H_2S and a number of commercial scale scrubbers have been used successfully in Thailand on pig waste produced biogas. Flaring unit will be included in the gas use system to avoid venting of biogas

The anaerobic system will produce two separate effluent streams. The first is solid, which due to biological activity are reduced to sludge. However this material accumulates in the digestion tank and will need to be removed periodically. The solids are removed to sludge drying beds and sold as fertilizer and soil conditioner. The second effluent stream will be stabilized liquid from the up-flow anaerobic reactor. These liquids are proposed to flow to a clarifier and then flow to a series of storage ponds for further use as irrigation water and recycle within the farm.

Technology and know-how transfer:

The project developer is implementing an integrated approach to ensure the project, including technology transfer, proceeds according to the plan. This approach included careful customization, specification and design of a complete swine waste treatment and power generation technology solution, identification and qualification of appropriate technology/services providers, supervision of the complete project installation, farm staff training, ongoing monitoring (by the project developer) and developing/implementing a complete Monitoring Plan using project developer staff. As part of this process, the project developer has specified a technology solution that will be self-sustaining (i.e., highly reliable, low maintenance, and operate with little or no user intervention). The materials and labor used in the base project activity are sources from the host country whenever economically possible. Training needs for the participating farms will include mainly system operation and maintenance, monitoring plan, record keeping and filing. Training will be provided by on-site training for the operators of the specific waste treatment system and electricity generating system for each specific farm.

A.7 Public funding of PoA

There are no public funding from Annex I part support this PoA.

SECTION B. Demonstration of additionality and development of eligibility criteria

B.1. Demonstration of additionality for PoA

(i) The proposed PoA is a voluntary coordinated action;

The proposed PoA is a voluntary coordinated action from ERDI. The main role of ERDI is to promote the implementation of Biogas technology, which utilized the captured methane as renewable energy. Without the PoA to provide additional incentives, the owner of the participating farms would not invest in such livestock waste treatment system.

(ii) If the PoA is implementing a voluntary coordinated action, it would not be implemented in the absence of the PoA;

The CDM PoA promoting livestock waste treatment and generating renewable energy is developed under the umbrella of a national plan to promote the use of energy from agricultural activity to reduce greenhouse gases. The plan faces significant financial barriers and the measures proposed under this CDM PoA are adding to the financial burden of the program.

A major problem associated with increased livestock production is that it also results in an increased amount of manure and dead animals during the grow-out period. Environmental problems may result if these by-products of the production process are improperly utilized or disposed of. The main environmental problems of concern are water pollution, air pollution, and land degradation. Water pollution may occur if nutrients from manure enter the water table because they are either improperly used or disposed of, or may be associated with improper disposition of dead animals that consequently release nutrients into the ground water as they decompose. Air pollution may result as the nitrogen in manure is converted to ammonium, and also through incineration of dead animals. Land degradation may occur if the carrying capacity of animals is too high, leading to over-grazing in the case of ruminants, or if the application of nutrients over a number of years causes build up of nitrogen, phosphorous and salt, resulting in reduced crop yields.

In addition there are no regulations in Thailand that require the implementation of livestock waste treatment nor incentives to do so with renewable energy generation, even though dependence and energy security are important issues in Thailand particularly with regards to imported fuel supplies. The high level of oil prices affects local manufacturers and households and has a negative impact on development. Renewable energy generation in the Thai economy are therefore essential to address concerns but are constrained by insufficient financial resources at a national level.

Besides financial barriers, the implementation of anaerobic livestock waste treatment system is constrained in Thailand due to a lack of awareness among farmers in the country. More than half of the biogas systems that have been installed in Thailand have low stability due to bad designs high initial investment cost[4]. There is therefore not a very successful experience on the implementation of projects such as the ones proposed under this PoA. Given the difficulty of implementation coupled with higher maintenance costs, many farmers still prefer dumping all animal waste in anaerobic lagoons, where there is little to no maintenance needed, and they stay dedicated to their primary activity which is the animal production not animal waste management.

Livestock waste treatment with renewable energy generation could not be successfully implemented in the past due to the high investment costs and the lack of technical skills to operate the system.

The experience up to now has demonstrated that without CDM revenues and technical assistance like the ones that could be provided by the ERDI institute, farmers wouldn't take the initiative to

[4] Final Report: Technology Potential for Biogas production from Biomass in Thailand, King Mongkutt University of Technology, Thonburi (KMUTT), November 2006

invest in animal manure treatment systems with energy generation systems in order to mitigate GHG emissions. The alternatives for the project implementers to the participation in the proposed CDM PoA is either develop a CDM project by their own means or not implement waste management systems, continuing the current common practice of anaerobic lagoons that continue to generate emissions into the atmosphere.

Therefore the intention of the proposed PoA is twofold: to provide the necessary means for the farmers in the country to be able to produce renewable energy for their own use, through an additional stream of revenues leveraged by carbon finance, while scaling up the use of animal waste management technologies in order to mitigate methane emissions. Not only will ERDI provide the means for the realization of the CER revenues, but they will provide the necessary technical assistance to the farmers (as owners of the patented technology to be implemented) to structure the waste management operation with renewable energy generation while ensuring the CDM requirements are being met.

The CDM revenues generated by this PoA will hence be used to help cover the PoA costs and ensure the continuity of the PoA over time.

In summary the objective of this PoA is to provide solid support to farmers with a technically strong coordinating/managing entity able to lead the process, providing financial assistance through realization of CER revenues along with technological training for the successful implementation of the animal waste management systems, so that the above mentioned barriers can be overcome. In essence, the voluntary coordinated action that will be implemented through this PoA, would not, and has not, been implemented in the absence of the PoA.

(iii) If the PoA is implementing a mandatory policy/regulation, this would/is not enforce;

Not Applicable.

(iv) If mandatory a policy/regulation is enforced, the PoA will lead to a greater level of enforcement of the existing mandatory policy/regulation.

Not Applicable.

B.2. Eligibility criteria for inclusion of a CPA in the PoA

Following the "*Standard for demonstration of additionality, development of eligibility criteria and application of multiple methodologies for programme of activities*" (Version 01.0), the eligibility criteria for inclusion of a CPA to be included in the PoA are as listed below:

1. The project boundary shall be within the geographical territory of Thailand. The location will be specified in each CPA-DD.
2. Confirmation letter from the CPA implementer sating that the CPA is not a component of another CDM programme, has not been registered as a project activity of another CDM project, is undergoing validation within another CDM project, nor is a debundled component of a large scale project activity. To this effect a **unique identification number** will be given to each farm included in the CPA-DD. **Geographical coordinates** of each farm will be the basis for the unique identification number. In addition, the CME will check the UNFCCC website to confirm that there is no other CDM project activity with the CPAs project name or geographic location.
3. The proposed CPAs shall use the same technologies as provided by ERDI, which include the construction of anaerobic biogas digesters to replace open lagoons; specific biogas digester technologies, and utilization or flaring of the captured biogas. This shall be described in specific CPA-DD. This shall be documented on the feasibility study and/or procurement plan will confirm the primary technology and biogas utilization situation.

4. The start date of the CPA, as defined by the CDM glossary of terms, shall not before 22/12/2009 (date of beginning of the Global Stakeholder Process posted on the UNFCCC website).

5. The proposed CPA meets the applicability conditions of methodology AMS III.D v18 by meeting and providing the following:

The eligibility criteria for enrolling the CPA are as follows:	Reference of the documentation of the compliance of the CPAs
(a) The swine population in the farm is managed under confined conditions;	Documented evidence from site visit by ERDI staff.
(b) Piggeries waste generated are not discharged into natural/public water ways;	As per the IEE and documented evidence from site visit by ERDI staff.
(c) In the baseline scenario the retention time of manure waste in existing anaerobic lagoon is at least 1 month;	Documented evidence on site visit along with information provided by CPA implementer: Dimension of existing lagoon/s and water consumption
(d) The depth of the existing anaerobic lagoon is at least 1 meter;	Documented evidence on site visit and provided by CPA implementer.
(e) No methane recovery and destruction by flaring, combustion or gainful use takes place in the baseline scenario;	Documented evidence from site visit by ERDI staff.
(f) The annual average temperature of baseline site where anaerobic manure treatment facility is located is higher than 5ºC.	Thailand has a mean annual temperature of 27.0 ºC, well over 5ºC. Source: Thai Meteorological Department, found online at http://www.tmd.go.th/en/climate.php?FileID=7
(g) The residual waste form the animal manure management system shall be handled aerobically.	Documented as per project design
(h) Technical measures shall be used to ensure that all biogas produced by the digester is used or flared.	Documented as per project design.
(i) The storage time of the manure after removal from the animal barns, including transportation, should not exceed 45 days before being fed into the anaerobic digester.	Documented evidence from site visit by ERDI staff.
(j) If the proposed CPA includes new facilities (Greenfield projects) and project activities involving capacity additions compared to the baseline scenario, these will only be eligible if they comply with the related and relevant requirements in the General Guidelines to SSC CDM methodologies	Documented as per project design.
(k) The requirements concerning demonstration of the remaining lifetime of the replaced equipment shall be met as described in the General Guidelines to SSC CDM methodologies.	Documented as per project design.
(l) The aggregate emission reductions should be less than or equal to 60 kt CO_2 equivalent annually.	Documented as per project design and ER calculation spreadsheet.

6. The proposed CPA shall also meet the following project activity criteria to be elegible under this PoA:

(a) The range of wastewater treatment system size should be between 300 m^3 to 20,000 m^3;	As per the IEE and documented as per project design.
(b) The project is not located in a protected area and/or disputed area;	As documented on the IEE Report of the farms
(c) The owner of the project has been authorized to operate at the project location;	Farms Business licences
(d) There is available space for the project activity at the existing project location;	IEE Report for farms.
(e) Availability of the necessary data (i.e. swine population etc.) for calculating of emission reduction and the crediting period as for the verification of emission reductions there needs to be reliable data at the farm.	Documented evidence from site visit by ERDI staff, along with evidence provided by the CPA implementer.
(f) Emission reductions claimed under the CPA are those derived only from avoided gas emissions into the atmosphere, from the use of methodology AMS.III.D. No credits will be claimed from any uses of the gas.	Documented as per project design
(g) The storage time of the manure after removal from the animal barns, including transportation, does not exceed 24 hours before being fed into the anaerobic digester while the dry matter content of the manure when removed from the animal barns is less than 20%.	It shall be documented on the CPA- DD that the digester shall be located at the farm site and that waste shall be flushed to make sure that waste flows directly to the digester with no storage time. This will be confirmed by a site visit by ERDI staff.

7. The proposed CPA meets the additonality conditions as per the "*Guidelines on the demonstration of additionality of small-scale project activities*" v9 (previously known as attachment A to Appendix B) by meeting and providing the following:

Additionality	
(a) If the farm is operating, it has an open anaerobic wastewater system in the baseline; however if the farm is a new facility or involves capacity additions compared to the baseline scenario, it must comply with criteria (r) above.	Documented evidence on site visit and provided by CPA implementer
(b) The technology used by the project activity is the same one provided by ERDI for all CPAs.	Documented on the signed contract between the participating farms and ERDI
(c) Project is not financially attractive without CDM revenues	Documented financial analysis in the CPA-DD demonstrates that the project is not financially attractive without the CDM revenues. The detailed IRR calculation and evidences to support the estimate of key parameter value will be provided in section B3 of each CPA-DD.
(d) The farm is compliant with the applicable Thai environmental rules and regulations	Compliance with the Notification of the Ministry of Natural Resources and Environment specifying the Effluent Standard for Pig Farm dated November 7, B.E. 2548 (2005), otherwise relevant Thai regulation(s) applicable at the time of decision making.

8. The project must have undertaken a stakeholder consultation as outlined in Section D. The list of attendees and minutes of the meeting shall be documented in the CPA-DD.

9. In case there is funding from Annex I country, the proposed CPA will provide an affirmation that funding, does not result in a diversion of official development assistance.

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B.3. Application of technologies/measures and methodologies

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The technology used is that of anaerobic wastewater treatment technologies. Anaerobic digestion technologies will capture methane for use in energy applications and provide other environmental benefits related to water and air quality, human health, and greenhouse gas reduction. The methodology therefore used is AMS-III.D: Methane recovery in animal manure management systems, version 18.0. This approved SSC baseline and monitoring methodology is approved for use in a PoA by the Executive Board at its fifty-eight meeting.

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B.4. Date of completion of application of methodology and standardized baseline and contact information of responsible person(s)/ entity(ies)

Date of completing this baseline section: 2/01/2009[6]

Name of person/entity determining the baseline:
Pongtip Puvacharoen, Carbon Finance Analyst
The World Bank
30th Floor, Siam Tower
989 Rama I Road, Pathumwan
Bangkok 10330
Thailand

With subsequent revision by
Juha Seppala
Claudia Barrera
Nontaya Krairiksh
World Bank Group, IBRD
Climate and Carbon Finance Unit
1818 H Street NW
Washington, DC 20433

The World Bank is not considered as project participant.

SECTION C. Management system

ERDI is the coordinating/managing entity (CME) of this program. Contractual arrangements will be signed with each participating farm, the installation of the anaerobic waste treatment system and the monitoring system. Data will be transmitted on a monthly basis to ERDI that will be in charge of the record keeping, while key operational data will be transmitted daily to ERDI via remote data access system.

(i) A record keeping system for each CPA under the PoA,

Data collected at the SSC-CPA level will be sent to ERDI that has designated one of its departments to be Project Implementation Unit (PIU) for collecting, treating and archiving CDM

[6] Date for completion for the first version of the PoA-DD for global stakeholder consultation.

data. This department is qualified to manage data and records as it is part of its normal assignment.

Paper and electronic records will be kept during the entire crediting period of each SSC-CPA (10 years) and two years after the crediting period. All the monitored parameters will be included in the Information System implemented by ERDI.

(ii) A system/procedure to avoid double accounting e.g. to avoid the case of including a new SSC-CPA that has been already registered either as a CDM project activity or as a SSC-CPA of another PoA,

ERDI is responsible for baseline assessment and verification of farm eligibility, hence, ERDI is also responsible for verifying that a new-SSC-CPA has not been already registered. Currently, there is only one PoA that will implement anaerobic waste treatment system for livestock in Thailand. The Designated National Authority will be consulted prior to the inclusion of the participating farm to confirm that the participating farm has not been register either as CDM project activities or as a CPA of another PoA.

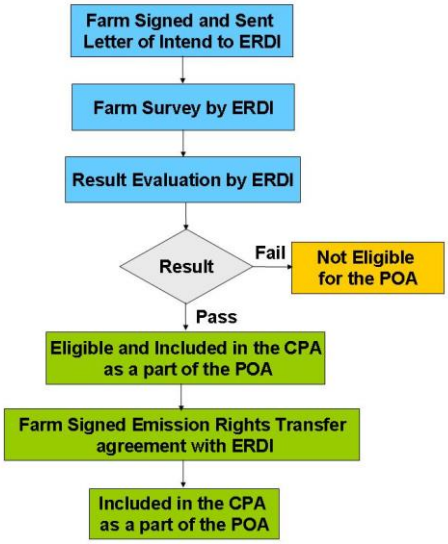
(iii) The SSC-CPA included in the PoA is not a de-bundled component of another CDM programme activity (CPA) or CDM project activity.

According to paragraph 2 of Appendix X to the Simplified Modalities and Procedures for Small-Scale CDM project activities (FCC/CP/2002/7/Add.3), a small-scale project is considered a debundled component of a large project activity if there is a registered small-scale activity or an application to register another small-scale activity:

1. With the same project participants;
2. In the same project category and technology;
3. Registered within the previous two years; and
4. Whose project boundary is within 1 km of the project boundary of the proposed small scale activity.

None of the four conditions are applicable to the SSC-CPAs of this proposed PoA, as a participating farm meeting of those criteria will be not be included in the SSC-CPA. Thus, it is not a debundled Small-Scale PoA. The procedure for farm selection is illustrated in Figure A.4.4.1.

Figure A.4.4.1 Participating Farm Eligibility Criteria Selection



(iv) The provisions to ensure that those operating the CPA are aware of and have agreed that their activity is being subscribed to the PoA;

Prior to the inclusion of a SSC-CPA in the proposed PoA, agreements for CERs ownerships will be signed between the coordinating agency and the participating farms. Signed contract between ERDI and the participating farm is also an eligibility criteria of the PoA.

SECTION D. Duration of PoA

D.1. Start date of PoA

15/05/2007 (Start date of PoA, ie the date in which the letter of intent between ERDI and the World Bank was signed)
07/11/2012 (start date of the crediting period of PoA)

D.2. Duration of the PoA

28 years

SECTION E. Environmental impacts

E.1. Level at which environmental analysis is undertaken

1. Environmental Analysis is done at PoA level ✓

The environmental analysis will be undertaken at the PoA level. An Initial Environmental Evaluation Report (IEE) and Environmental Management Framework (EMF) have been prepared for

submission to the DNA. No environmental impact analysis is required for this type of project under the Thai regulation.

2. Environmental Analysis is done at SSC-CPA level ✓

Each participating farm will adopt its own Environmental Management Plan (EMP) drawn from the IEE of the POA.

E.2. Analysis of the environmental impacts

The analysis of environmental impacts of the project activities was undertaken in comparison of the impacts of the old anaerobic lagoon system. Four aspects of environmental impacts were identified as a result of the wastewater treatment operations, which are:

Transboundary Impacts
Air pollution – the biogas generated will be use to generate electricity for onsite consumption, this would reduce fossil fuel based electricity generation and related suspended particles, SO_x and NO_x are therefore reduced; and

Wastewater pollution – the new wastewater system can remove more than 90% of organic matter in the wastewater so that environmental impacts of possible overflow during the rainy season or of groundwater contamination will be significantly reduced.

Local Impacts
Odour – since the new wastewater treatment system operates in a closed system, undesirable odour will be significantly reduced; and

Solid waste disposal – the new system has installed a sand drying bed for sludge separation which will improve the handling of solid waste, whereby the environmental impacts is reduced.

SECTION F. Local stakeholder comments

F.1. Solicitation of comments from local stakeholders

The nationwide stakeholder consultation was organized on 23/03/2009 at The Twin Towers Hotel Bangkok. Invitations were sent by letters with follow up telephone calls to confirm recipient of the invitations. The consultation was well attended by 94 people from government and private organization, farm owners, and media (1). The number of people and organizations are summarised in Table D.2.1.

Table D.2.1 Number of participants and organization participated

Participant	No. (person)	No. (organization
Farmer Owner	**21**	**13**
ERDI's Agents	**21**	**10**
Public and Private organization	**51**	**20**
Media	**1**	**1**
Total	**94**	**44**

In addition, questionnaires were distributed at the stakeholder consultation. The questionnaire return rate was 42.55%.

F.2. Summary of comments received

The consultation was divided into 4 sessions: 1) stakeholder consultation objectives by ERDI, 2) CDM project development in Thailand by Thailand Greenhouse Gas Management Organization (TGO), 3) Programmatic CDM concept by the World Bank, and 4) Introduction to Thailand Small Scale Livestock Waste Management Program.

The questions and comments raised as well as responds provided during the consultation are divided into three categories: Program Design, Program Eligibility and Program Recommendation (summarised in section D.4).

The questionnaire returned indicated the participants agreed and support the POA development. The expectation of the POA is to provide economic incentive for the participating farm, reduce complains related to environmental issues and improve farm operational standards. The questionnaire also indicated that the participants are highly satisfied with the information provided at the consultation, which allows them to have better understand of CDM and Carbon Market issue. The responses to concerns and questions raised during the consultation were highly satisfactory. It was also suggested that additional information on the program eligibility and participating procedure should be available from ERDI's website.

F.3. Report on consideration of comments received

Questions	Response
Program Design	
Will the program include other type of livestock waste such as chicken and cattle?	It is possible to include cattle and chicken if the farm can pass the eligibility criteria and can follow the design project activity.
Will there be any financial support for participating farms under this program?	It is possible to seek for local financial support for example, Bank of Agriculture and Agricultural Cooperative and Thailand Environment Fund. But the consideration will depend upon the fund managers.
How will the Initial Environmental Evaluation Report be prepared for this program?	The Initial Environmental Evaluation Report will act as a framework, and while each individual farm should have their own environment and social action plan.
If one farm under the CPA failed to produce emission reduction, what would be the consequence for that CPA?	The emission reduction for the CPA will be reduced. Also under the contract signed between ERDI and farm, ERDI will reserve a guarantee (10%) from each farm. If the farm fail to operate then the reserved will be use to cover expenses of the CPA for other farms. Hence, there should be no impact on other farms in the CPA.
If the farm is interested in to join the program, what should the farm do?	The farm should contact ERDI staffs or agents to sign the Letter of Intend to express their interest before verification of farm eligibility.
Program Eligibility	
If the farm already installed biogas system, but has planned to expand the farm, will the farm be eligible to join the program?	Only if the wastewater generated from the expanded part the farm has been directed anaerobic lagoon with methane capture and combustion.
What are the minimum farm sizes that will	The minimum farm size for the program is 2,000 SPP or equivalent to 300 m^3 system. The

Questions	Response
be eligible for the program?	technology will is not economically appropriate for smaller size farm.
If the farm has methane recovery and biogas utilization in place, will the farm be eligible to join the program?	This type of farm will not be eligible.
Program Recommendation	
Program document should be disseminated through other media such as newspaper announcement and television.	ERDI will consider more options for information dissemination.
The program should coordinate with Ministry of Science and Technologies to seek the possibility of low cost monitoring equipment.	ERDI will try to coordinate with Ministry of Science and Technologies to see if it is possible.

SECTION G. Approval and authorization

>>Letters of Approval are available from the Parties involved in the PoA: Thailand (Host Party) and Portugal.

PART II. Generic component project activity (CPA)

SECTION A. General description of a generic CPA

A.1. Purpose and general description of generic CPAs

A typical CPA will be a group of farms or an individual farm that will implement the project activity by converting existing anaerobic lagoons that currently emit methane, to closed advanced anaerobic treatment digesters with biogas capture and power generation in Thailand. Each SSC-CPA is expected to reduce up to 60,000 tCO_2e of greenhouse gas annually.

The treatment of livestock manure by way of anaerobic digester processes leads to the production of a biogas consisting of 65-70% methane (CH_4). Currently all farms employ normal scraping and hose-down cleaning of the animal waste with a series of anaerobic lagoons within the farms premises. This waste material is left to decay in the individual facility's open lagoon system, producing significant amounts of methane that is emitted directly to the atmosphere. This current livestock waste management practices contributes to significant air (odour) and water pollution in the areas close to the farms. The project will apply anaerobic digesters which will capture the biogas and use it to generate electricity for own farm consumption, or sale to national grid. The PoA does not contemplate the use of biogas for uses other than electricity generation. It is important to note that the PoA will not claim credits for renewable energy generation, nor for any other use of the collected biogas, as explained in the sections below.

In addition to improving the local environment quality, the project will also deliver local community benefits related to the creation of new jobs during the construction, operation and maintenance stages of the livestock wastewater management system and to the utilization of methane gas (CH_4) as renewable energy resource for the farms. The project activities can also be replicated in other farms around the country which will lead to environmental awareness related to livestock waste management, renewable energy, and climate change.

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

B.1. Reference of methodology(ies) and standardized baseline(s)

The selected methodology is AMS-III.D. Methane recovery in animal manure management systems, version 18.0. This approved SSC baseline and monitoring methodology is approved for use in a PoA by the Executive Board at its fifty-eight meeting.
It is found on the UNFCCC CDM website at the following link:
http://cdm.unfccc.int/methodologies/DB/2C25M4WA2W2XCMG5ETXE2CBHZOPRZU

B.2. Applicability of methodology(ies) and standardized baseline(s)

The project meets the requirement of methodology AMS-III.D. -Version 18 as follows:

Applicability of AMS-III.D - Version 18	Project activity
This methodology covers project activities involving the replacement or modification of existing anaerobic manure management systems in livestock farms to achieve methane recovery and destruction by flaring/combustion or gainful use of the recovered methane. This methodology is only applicable under the following conditions:	The project activity involves the replacement of existing anaerobic manure management systems which emits methane in livestock farms to achieve methane recovery and destruction by combustion/flaring use of the recovered methane, at an alternative site on existing farm.
(a) The livestock population in the farm is managed under confined conditions;	(a) The livestock population in participating farm is managed under confined conditions. This is one of the eligibility criteria;
(b) Manure or the streams obtained after treatment are not discharged into natural water resources (e.g. river or estuaries), otherwise AMS III.H. shall be applied;	(b) Biogas residue after treatment are not discharged into natural water resources;
(c) The annual average temperature of baseline site where anaerobic manure treatment facility is located is higher than 5°C,	(c) The annual average temperature Thailand ranges between 27 °C[7] higher than 5°C.
(d) In the baseline scenario the retention time of manure waste in the anaerobic treatment system is greater than 1 month, and in case of anaerobic lagoons in the baseline, their depths are at least 1 m;	(d) In the baseline scenario the retention time of manure waste in open lagoon is 90 days (to accommodate wastewater generated during monsoon season, and the average depth of lagoons is deeper than 1 m. This is one of the eligibility criteria;
(e) No methane recovery and destruction by flaring, combustion or gainful use takes place	(e) No methane recovery and destruction by flaring, combustion or gainful use takes place in the baseline scenario. This is one of the

[7] Reference: Thailand Meteorological Department 15 December 2008, http://www.tmd.go.th/climate/climate.php?FileID=7

Applicability of AMS-III.D - Version 18	Project activity
in the baseline scenario.	eligibility criteria
The project activity shall satisfy the following conditions: (a) The residual waste from the animal manure management system 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. (b) Technical measures shall be used (e.g. flared, combusted) to ensure that all biogas produced by the digester is used or flared. (c) The storage time of the manure after removal from the animal barns, including transportation, should not exceed 45 days before being fed into the anaerobic digester. If the project proponent can demonstrate that the dry matter content of the manure when removed from the animal barns is larger than 20%, this time constraint will not apply.	(a) The sludge from the system will be handled aerobically. The sludge will be dried on sand drying bed with thickness less than 20 cm. to ensure that the sludge will not result in methane emissions. The dried sludge, which does not result in methane emissions, will be applied to the farmland. (b) The captured biogas for power generation, ERDI will make sure the same technology is installed at each CPA. (c) The Anaerobic Digesters for the projects are on site, so it flows directly into the anaerobic digester after the daily barn cleaning routine, therefore in no case will it exceed 1 day.
The recovered methane from the above measures may also be utilized for the following applications instead of flaring or combustion: (a) Thermal or electrical energy generation directly; or (b) Thermal or electrical energy generation after bottling of upgraded biogas; or (c) Thermal or electrical energy generation after upgrading and distribution: i. Upgrading and injection of biogas into a natural gas distribution grid with no significant transmission constraints; or ii. Upgrading and transportation of biogas via a dedicated piped network to a group of end users.	The recovered methane will be utilized for electrical energy generation directly
New facilities (Greenfield projects) and project activities involving capacity additions compared to the baseline scenario are only eligible if they comply with the related and relevant requirements in the General Guidelines to SSC CDM methodologies.	This criteria has been added as an eligibility criteria, hence will be demonstrated within the CPA-DD.
The requirements concerning demonstration of the remaining lifetime of the replaced equipment shall be met as described in the General Guidelines to SSC CDM	This criteria has been added as an eligibility criteria, hence when applicable will be demonstrated within the CPA-DD.

Applicability of AMS-III.D - Version 18	Project activity
methodologies.	
Measures are limited to those that result in aggregate emission reductions of less than or equal to 60 ktCO_2 equivalent annually from all type III components of the project activity.	The estimated annual emission reduction from manure management improvement for each CPA will be less 60 kt CO_2e.

B.3. Sources and GHGs

Source		Gas	Included/Excluded	Justification/Explanation
Baseline	Direct emissions from the uncovered anaerobic lagoon	CH_4	Included	Main emission source
		N_2O	Excluded	Excluded for simplification
		CO_2	Excluded	Excluded for simplification
	Emissions from Electricity consumption	CH_4	Excluded	Excluded for simplification
		N_2O	Excluded	Excluded for simplification
		CO_2	Excluded	Excluded for simplification
	Emissions from thermal energy generation	CH_4	Excluded	Excluded for simplification
		N_2O	Excluded	
		CO_2	Excluded	
Project Activity	Emissions from thermal energy generation	CH_4	Excluded	Even though they are expected to be minor, emissions from fossil fuel combustion have been included
		N_2O	Excluded	
		CO_2	Included	
	Emissions from onsite electricity use	CH_4	Excluded	Excluded for simplification
		N_2O	Excluded	
		CO_2	Included	Because electricity is generated from collected biogas in the project activity, and the electricity generated are much more than the electricity consumed by the manure management facilities used by the project activity, these emissions are zero.
	Direct emissions from the anaerobic digester process	CH_4	Included	Main emission source
		N_2O	Excluded	Excluded for simplification
		CO_2	Excluded	Excluded for simplification
	Direct emissions from the sludge pond	CH_4	Excluded	Excluded for simplification
		N_2O	Excluded	Excluded for simplification
		CO_2	Excluded	Excluded for simplification

The geographical boundary of the CPA is within Thailand. The participating farms under the CPA are located in Thailand, therefore within the geographical boundary of the registered PoA.

B.4. Description of baseline scenario

As per AMS III.D, the baseline scenario of the methane recovery component is the situation where, in the absence of the project activity, animal manure is left to decay anaerobically within the project boundary and methane is emitted to the atmosphere. The criteria for inclusion of the activity (see section B.2 of Part I) that helps limit the baseline situation to that which are consistent with the use of AMS III.D include:

- The piggery farm has livestock populations managed under confined conditions.
- The piggery farm has manure or the streams obtained after treatment is not discharged into natural water resources (e.g. rivers and estuaries).
- The baseline system of waste management is an open anaerobic system with no methane recovery and destruction by flaring, combustion or gainful use.
- For anaerobic treatment systems in the baseline, the retention time of manure waste must be greater than 1 month.
- For anaerobic lagoons in the baseline the depth is at least 1 m.

These will be identified as part of the development of each CPA through site inspections, measurements and documented accordingly. The emissions from the baseline scenario from each CPA will be calculated in accordance with AMS III.D and these formulas are described in Section B.6 below.

Additionally, the characteristics of the manure and the management system employed are important factors to defining the baseline for each CPA.

The key characteristics of the manure are the amount of organic material in the manure or volatile solids (VS) content and the maximum amount of methane potentially produced from the manure (B_o). For each CPA, the proponent has a choice of estimating these parameters using national or regional defaults or if the source of the livestock is from an Annex I country, defaults from those countries. For VS they also have the option of adjusting the value based on site-specific animal weight conditions.

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The manure management system employed affects the Methane Correction Factor (MCF) which represents the degree to which the B_o is achieved and therefore the amount of the potential methane emissions that could be released. The MCF will be determined for each CPA using IPCC defaults.

The details of the estimation of these parameters and other constants in the baseline calculations are listed in section B.6 below.

B.5. Demonstration of eligibility for a generic CPA

This small-scale CPA meets all of the defined for the inclusion of a small-scale CPA as stated in B.2.

The eligibility criteria for enrolling the CPA are as follows:

1. The CPA is located in Thailand (see Appendix I).
2. A Confirmation letter from the CPA implementer has been received sating that the CPA is not a component of another CDM programme, has not been registered as a project activity of another CDM project, is undergoing validation within another CDM project, nor is a debundled component of a large scale project activity. The **unique identification number** of this CPA is: XXXX: and the g**eographical coordinates** are shown in Section A1. In

addition, the CME has checked the UNFCCC website, and did not find the projects name or coordinates.

3. The CPA use the same principle technology as stated in the PoA. The feasibility study confirms the primary technology and biogas utilization situation.

4. The start date of the CPA is XXX.

5. The proposed CPA meets the applicability condition of methodology AMS III.D version 18 as follows:

The eligibility criteria for enrolling the CPA are as follows:	**Reference of the documentation of the compliance of the-CPAs**
(a) The swine population in the farm is managed under confined conditions;	Yes, all participating farms in the CPA manage their livestock under confined conditions as per the IEE 20xx and/or Baseline Farm Survey 20xx.
(b) Piggeries waste generated are not discharged into natural/public waterways;	No, livestock waste from participating farms has not been discharged into natural/public waterways. Livestock waste was kept in open anaerobic lagoon as per the IEE 20xx and/or Baseline Farm Survey 20xx.
(c) In the baseline scenario the retention time of manure waste in existing anaerobic lagoon is at least 1 month;	Yes, the retention time of manure waste in anaerobic lagoon is at least 1 month as per the IEE 20xx and/or Baseline Farm Survey 20xx and/or mini Project Implementation Plan (mini PIP) 20xx. The hydraulic retention time of each farm in the CPA is as follows: • [Farm 1 name]: xxx days • [Farm 2 name]: xxx days • [Farm 3 name]: xxx days
(d) The depth of the existing anaerobic lagoon is at least 1 meter;	Yes, the depth of the existing anaerobic lagoon is at least 1 meter as per the IEE 20xx and/or Baseline Farm Survey 20xx.
(e) No methane recovery and destruction by flaring, combustion or gainful use takes place in the baseline scenario;	No, there is no methane recovery and destruction by flaring combustion or gainful use takes place in the baseline scenario of the participating farms since livestock waste was kept in open anaerobic lagoon as per the IEE 20xx and/or Baseline Farm Survey 20xx.
(f) The annual average temperature of baseline site where anaerobic manure treatment facility is located is higher than 5^{o}C.	The annual average temperature for each farm is as follows: [Farm 1 name]: xxx days [Farm 2 name]: xxx days [Farm 3 name]: xxx days Source: Thai Meteorological Department, Automatic Weather System (AWS), found online at http://www.aws-observation.tmd.go.th/web/reports/weather_years.asp
(g) The residual waste form the animal manure management system shall be handled aerobically.	The residual waste from the animal manure management systems will be handled aerobically as per Section B.6. of this CPA-DD.
(h) Technical measures shall be used to ensure that all biogas produced by the digester is used or flared.	All biogas produced by the digester is used or flared as per the CPA-DD and the mini Project Implementation Plan (miniPIP).

The eligibility criteria for enrolling the CPA are as follows:	Reference of the documentation of the compliance of the-CPAs
(i) The storage time of the manure after removal from the animal barns, including transportation, should not exceed 45 days before being fed into the anaerobic digester.	The storage time of the manure after removal from the animal barns, including transportation, does not exceed 45 days as per the mini Project Implementation Plans.
(j) If the proposed CPA included new facilities (Greenfield projects) and project activities involving capacity additions compared to the baseline scenario, this will only be eligible if they comply with the related and relevant requirements in the General Guidelines to SSC CDM methodologies	The project [does/does not] involve a new facility, [fill out with details on facility and how it complies with the related and relevant requirements in the General Guidelines to SSC CDM methodologies if it is a Greenfield project]
(k) The requirements concerning demonstration of the remaining lifetime of the replaced equipment shall be met as described in the General Guidelines to SSC CDM methodologies.	The project activity does not seek to retrofit or modify an existing unit or equipment therefore this does not apply.
(l) The aggregate emission reductions should be less than or equal to 60 kt CO_2.	Documented as per Section B.6 and ER calculation spreadsheet. The aggregate emission reductions of the CPA calculated ex-ante is XXX tCO_2e is less than 60,000 tCO_2e.

6. The proposed CPA meets the project activity criteria to be eligible under this PoA:

(a) The range of wastewater treatment system size should be between 300 m^3 to 20,000 m^3;	Yes, the wastewater treatment system size for the participating farm in this CPA are of the size at xxxx m^3 which is within the specified range as per the IEE 20xx and/or Baseline Farm Survey 20xx.
(b) The project is not located in a protected area and/or disputed area;	No, there are no participating farms located in protected area as documented on their IEE Report(s)
(c) The owner of the project has been authorized to operate at the project location;	Yes, all participating farms have been authorized to operate as per their Business license.
(d) There is available space for the project activity at the existing location;	Yes, all participating farms have available space for the new treatment system at existing project location as per the IEE Report.
(e) Availability of the necessary data (i.e. swine population etc.) for calculating of emission reduction and the crediting period as for the verification of emission reductions there needs to be reliable data at the farm.	The participating farms provided necessary data for calculating of emission reduction and the crediting period as per the IEE 20xx and/or Baseline Farm Survey 20xx and/or mini PIP 20xx.
(f) Emission reductions claimed under the CPA are those derived only from avoided gas emissions into the atmosphere, from the use of methodology AMS-III.D. No credits will be claimed from any uses of the gas.	The emission reductions to be claimed from this CPA is only those accounted in the methodology AMS-III.D as per the demonstration in section B.6.3 of this CPA-DD.

7. The proposed CPA meets the additonality conditions as per the "*Guidelines on the demonstration of additionality of small-scale project activities*" v9 (previously known as attachment A to Appendix B) as follows:

Additionality	
(a) If the farm is operating, it has an open anaerobic wastewater system in the baseline; however if the farm is a new facility or involves capacity additions compared to the baseline scenario, it must comply with criteria (r) above.	The farm is operating an open anaerobic wastewater system in the baseline as documented on the site visit by LBP [and XXX – include other participants]. In addition the project provided [the IEE 20xx and/or Baseline Farm Survey 20xx] where it has also been documented that the site operates an open anaerobic lagoon.
(b) The technology used by the project activity is the same one provided by ERDI for all CPAs.	Documented on the signed contract between the participating farms and ERDI
(c) Project is not financially attractive without CDM revenues	Documented financial analysis in section B.3 and Annex 3 "Financial Analysis" of this CPA-DD, demonstrates that the project is not financially attractive without the CDM revenues
(d) The farm is compliant with the applicable Thai environmental rules and regulations	The participating farms are in compliance with the Notification of the Ministry of Natural Resources and Environment specifying the Effluent Standard for Pig Farm dated November 7, B.E. 2548 (2005) as per the IEE 20xx.

8. The project has undertaken a stakeholder consultation as outlined in Section F. The lists of attendees and minutes of the meeting have been documented below.

9. There is not funding from Annex I country.

B.6. Estimation of emission reductions of a generic CPA

B.6.1. Explanation of methodological choices

The emission reductions achieved by the project activity will be determined ex-post through direct measurement of the amount of methane fuelled, flared or gainfully used.

$$ER_y = BE_y - PE_y$$

Where:

ER_y :	Emission reductions achieved by the project activity for year "y" (tCO_2 e)
BE_y :	Baseline emissions calculated
PE_y :	Project emissions calculated

Baseline emissions are determined as follows:

$$BE_y = GWP_{CH4} * D_{CH4} * UF_b * \sum_{j,LT} MCF_{j,LT} * N_{LT,y} * VS_{LT,y} * MS\%_{B,j}$$

Where:

BE_y :	Baseline emissions in year "y" (tCO_2e)
GWP_{CH4} :	Global Warming Potential (GWP) for methane (25)
D_{CH4} :	CH_4 density (0.00067 t/m^3 at room temperature (20 ºC) and 1 atm pressure).
LT:	Index for all types of livestock

j: Index for animal waste management system

MCF_j: Annual methane conversion factor (MCF) for the baseline animal waste management system "j"

$B_{O,LT}$: Maximum methane producing potential of the volatile solid generated for animal type "LT" (m^3 CH_4/kg dm)

$N_{LT,y}$: Annual average number of animals of type "LT" in year "y" (numbers)

$VS_{LT,y}$: Volatile solids for livestock "LT" entering the animal manure management system in year "y" (on a dry matter weight basis, kg dm/animal/year)

$MS\%_{Bl,j}$: Fraction of manure handled in baseline animal manure management system "j"

UF_b: Model correction factor to account for model uncertainties (0.94)

Volatile solids for livestock according to 2006 IPCC Guidelines for National Greenhouse Gas, use IPCC default value in Table 10A-7 Manure Management Methane Emission Factor Derivation for Market Swine, and Table 10A-8 Manure Management Methane Emission Factor Derivation for Breeding Swine. There is no VS data available from nationally published resource. In case default IPCC values for VS are adjusted for a site-specific average annual weight, the following formula shall be used:

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Volatile solid for livestock "LT" entering the animal manure management system "j":

$$VS_{Ly} = \left(\frac{W_{S,i}}{W_{default}}\right) * VS_{default} * nd_y$$

Where

$W_{S,i}$: Average animal weight of a defined livestock population at the site (kg)

$W_{default}$: Default average animal weight of a defined population, this data is sourced from IPCC 2006 (kg)

$VS_{default}$: Default value for the volatile excretion rate per day on a dry-matter basis for a defined livestock population (kg dm/animal/day)

nd_y: Number of days in year "y" where the animal manure management system is operational

The annual average number of animals ($N_{LT,y}$) are determined as follows:

$$N_{LT,y} = N_{da,y} * \left(\frac{N_{p,y}}{365}\right)$$

Where:

$N_{da,y}$ Number of days animal is alive in the farm in the year *y* (numbers)

$N_{p,y}$ Number of animals produced annually of type *LT* for the year *y* (numbers)

The calculation of the average number of animals ($N_{LT,y}$) is done monthly based on each farms internal records filled in by farm manager or assigned personnel. It presents the records of animal entries (purchase; births, internal transfer) and exit (ex: sale, death, internal transfer) and the final monthly record of animals per animal category (ex: nursery, farrow, fattening 1 and fattening 2, breeding male, breeding female, pregnant sow).Using this approach for calculating $N_{LT,y}$, it is not necessary to calculate separately an $N_{da,y}$ and $N_{p,y}$, since the number of days the animal are alive

($N_{da,y}$) and the number of animals produced per category LT ($N_{p,y}$) are already implicitly considered in the monthly records and taken into account when calculating $N_{LT,y}$. The farms internal records with weekly logs are then the input for the emission reduction calculation spreadsheet and aggregates the monthly average number of animals per animal category per farm for all farms included in the PDD

Project activity emissions are determined as follows:

Project activity emissions consist of:

a) Physical leakage of biogas in the manure management systems which includes production, collection and transport of biogas to the point of flaring/combustion or gainful use ($PE_{PL,y}$);
b) Emissions from flaring or combustion of the gas stream ($PE_{flare,y}$);
c) CO_2 emissions from use of fossil fuels or electricity for the operation of all the installed facilities ($PE_{power,y}$).
d) CO_2 emissions from incremental transportation distances ($PE_{transp,y}$).
e) Emissions from the storage of manure before being fed into the anaerobic digester ($PE_{storage,y}$).

$$PE_y = PE_{PL,y} + PE_{flare,y} + PE_{power,y} + PE_{transp,y} + PE_{storage,y}$$

Where

PE_y: Project emissions in year "y" (tCO_2e)

$PE_{PL,y}$: Emissions due to physical leakage of biogas in year "y" (tCO_2e)

$PE_{flare,y}$: Emissions from flaring or combustion of the biogas stream in the year "y" (tCO_2e)

$PE_{power,y}$: Emissions from the use of fossil fuel or electricity for the operation of the installed facilities in the year "y" (tCO_2e)

$PE_{transp,y}$: Emissions from incremental transportation in the year *y* (tCO_2e);

$PE_{storage,y}$: Emissions from storage of manure (tCO_2e)

As explained in the PoA-DD, waste collection from all farms described in this program are collected daily or every other day by hose flushing all material through a series of collection channels, operating by gravity. These channels, under the CPAs, will be connected to the waste treatment system installed at each farm as designed by the ERDI patented technology. This means that as per the technology to be implemented, the waste material will be flushed/pumped every day to the anaerobic digester following a daily digester charging schedule. Therefore, since there will be no incremental transportation under this PoA, as manure management systems will be implemented at the farms, and at the same time there will be no storage of manure as it will flow directly from the barns to the manure management system, the last two terms are determined to be zero. The other sources of project emissions are calculated as follows:

Project emissions due to physical leakage of biogas in year "y" ($PE_{PL,y}$)

$$PE_{PL,y} = GWP_{CH_4} \cdot \sum_{LT} B_{0,LT} \cdot N_{LT,y} \cdot VS_{LT,y} \cdot MS\%_{i,y}$$

Where:

$MS\%_{i,y}$: Fraction of manure handled in system "i" in year "y"

Project emissions from flaring of biogas stream ($PE_{flare,y}$)

Methane may be released as a result of incomplete combustion in case of biogas use for electricity production. To calculate project emissions from flaring of a residual gas stream containing methane ($PE_{flare,y}$) the *"Tool to determine project emissions from flaring gases containing Methane"* will be used.

Emissions due to flaring of biogas in year "y" (tCO_2e)

$$PE_{flare,y} = \sum_{h=1}^{8760} TM_{RG,h} * (1 - \eta_{flare,h}) * \frac{GWP_{CH4}}{1000}$$

Where:

$TM_{RG,h}$: Mass flow rate of methane in the residual gas in the hour *h* (kg/h)

$\eta_{flare,h}$: Flare efficiency in hour *h*

Mass flow rate of methane in the residual gas in the hour *h*

$$TM_{RG,h} = FV_{RG,h} * fv_{CH4,RG,h} * \rho_{CH4,n}$$

Where:

$FV_{RG,h}$: Volumetric flow rate of the residual gas in dry basis at normal (Nm^3/h) conditions in hour *h*

$fv_{CH4,RG,h}$: Volumetric fraction of methane in the residual gas on dry basis in hour *h* (NB: this corresponds to fvi,RG,h where *i* refers to methane).

$\rho_{CH4,n}$: Density of methane at normal conditions

The list of parameters, as required under the "*Tool to determine project emissions from flaring gases containing Methane"* will be monitored ex-post and $PE_{flare,y}$ will be adjusted accordingly.

Project emissions from the use of fossil fuel or electricity for the operation of the installed facilities *$PE_{power,y}$*

a) Project emissions from electricity consumption in year y ($PE_{EC,y}$)

As per the methodology, project emissions from electricity consumption are determined as per the procedures described in AMS-I.D "*Grid connected renewable electricity generation*". The following formula will be used to calculate project emissions from electricity consumption in year y.

$$PE_{EC,y} = \sum_{j} EC_{PJ,j,y} \times EF_{EL,j,y} \times (1 + TDL_{j,y})$$

$PE_{EC,y}$ = Project emissions from electricity consumption in year *y* (tCO_2/yr)
$EC_{PJ,y}$ = Quantity of electricity consumed by the project electricity consumption source *j* in year *y* (MWh/yr)
$EF_{EL,j,y}$ = Emission factor for electricity generation for source *j* in year *y* (tCO_2/MWh)
$TDL_{j,y}$ = Average technical transmission and distribution losses for providing electricity to source *j* in year *y*
j = Sources of electricity consumption in the project
k = Sources of electricity consumption in the baseline
l = Leakage sources of electricity consumption

In a case that the farm is connected to the grid, Option A will be used. The combined margin emission factor of the applicable electricity system is calculated, using the procedures in the "*Tool to calculate the emission factor for an electricity system*" ($EF_{EL,j/k/l,y} = EF_{grid,CM,y}$). The emission factor for an electricity system will be calculated ex-post for the year relevant to CPAs included under the PoA.

b) Project emissions from combustion of fossil fuel in process *j* in year y ($PE_{FC,i,y}$)

As per the methodology, for project emissions from fossil fuel consumption, the emission factor for the fossil fuel shall be used (tCO_2/tonne). Local values are to be used, if local values are difficult to obtain, IPCC default values may be used. The CO_2 emissions from fossil fuel combustion in process *j* are therefore calculated, as follows:

$$PE_{FC,j,y} = \sum_{i} FC_{i,j,y} \times COEF_{i,y}$$

Where:

$PE_{FC,j,y}$ = CO_2 emissions from fossil fuel combustion in process j during the year *y* (tCO_2e/yr);
$FC_{i,j,y}$ = Quantity of fuel type *i* combusted in process *j* during the year *y* (mass or volume

unit/yr);
$COEF_{i,y}$ = CO_2 emission coefficient of fuel type *i* in year *y* (tCO_2/mass or volume unit)
i Fuel types combusted in process *j* during the year *y*

Due to data availability, $COEF_{i,y}$ is calculated following Option B of the Tool (based on net calorific value and CO_2 emission factor of the fuel type i) as follows:

$COEF_{i,y} = NCV_{i,y} * EF_{CO2i,y}$
Where
$NCV_{i,y}$ = Net calorific value of the fuel type *i* in year *y* (GJ/ m^3)
$EF_{CO2i,y}$ = CO_2 emission factor of fuel type *i* in year *y* (tCO_2/GJ)

Leakage

AMS-III.D, states that no leakage calculation is required.

B.6.2. Data and parameters fixed ex-ante

Data / Parameter:	**Capacity / for each participating farm**
Data unit:	kW
Description:	Installed generator capacity in each farm
Source of data:	Farm Specific
Value(s) applied:	[XXX]
Choice of data or Measurement methods and procedures:	The capacity of electricity generator is varied depending on the size of the system and the amount of biogas generated.
Purpose of data:	Calculation of project emissions
Additional comment:	-

Data / Parameter:	$MS\%_{BL,j}$
Data unit:	%
Description:	Fraction of manure being treated by the system
Source of data:	Project design
Value(s) applied:	100
Choice of data or Measurement methods and procedures:	The current practice in the participating farms is to flush all manure into their open anaerobic lagoons. Therefore the fraction of manure being treated by the system is 100%.
Purpose of data:	Calculation of baseline emissions
Additional comment:	-

Data / Parameter:	GWP_{CH4}
Data unit:	CO_2e
Description:	Global Warming Potential of Methane
Source of data:	2007 IPCC Fourth Assessment Report
Value(s) applied:	21 for the first commitment period of the KP 25 for the second commitment period of the KP
Choice of data or Measurement methods and procedures:	As per the Standard for Application of the GWP to CDM project activities and programmes of activities, for the second commitment period of the Kyoto Protocol. EB69 Annex 3. Based on values found online at http://www.ipcc.ch/publications_and_data/ar4/wg1/en/ch2s2-10-2.html#table-2-14
Purpose of data:	Calculation of baseline/project emissions
Additional comment:	-

Data / Parameter:	D_{CH4}
Data unit:	t/m3
Description:	Density of methane at room temperature (20°C) and 1 atm pressure
Source of data:	AMS-III.D Version 18, Paragraph 10
Value(s) applied:	0.00067
Choice of data or Measurement methods and procedures:	Value stated in AMS-III.D Version 18, Paragraph 10
Purpose of data:	Calculation of baseline emissions
Additional comment:	-

Data / Parameter:	MCF_j
Data unit:	%
Description:	Annual methane conversion factor (MCF) for baseline animal waste management system "j"
Source of data:	Table 10.17 of 2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 4 Chapter 10
Value(s) applied:	80
Choice of data or Measurement methods and procedures:	Currently the waste generated is directed to open lagoons. The average temperature in Thailand is greater than 27°C (source: http://www.tmd.go.th/climate/climate.php?FileID=7).
Purpose of data:	Calculation of baseline emissions
Additional comment:	-

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Data / Parameter:	$B_{o,LT}$
Data unit:	m^3CH_4/kg dm
Description:	Maximum methane producing potential of the volatile solid generate for animal type "LT"
Source of data:	IPCC Guidelines for National Greenhouse Gas Inventories Annex 10A.2 Tables 10A-7 and 10A-8
Value(s) applied:	

Region	Breeding swine	Market swine
North America	0.48	0.48
Western Europe	0.45	0.45
Eastern Europe	0.45	0.45
Oceania	0.45	0.45
Latin America	0.29	0.29
Africa	0.29	0.29
Middle East	0.29	0.29
Asia	0.29	0.29
Indian Subcontinent	0.29	0.29

Choice of data or Measurement methods and procedures:	AMS-III.D. Version 18, Paragraph 10 stated that if country specific B_o values are not available, default values provided in tables 10 A-4 to 10 A-9 of 2006 IPCC Guidelines for National Greenhouse Gas Inventories volume 4 Chapter 10 can be used. In Thailand, country specific value is not available hence adopting the value from IPCC. The chosen values for eastern European breed were applied in the baseline calculations as the swine breed and fattened in the participating farms are of Eastern European origin.[8] For baseline emissions each farm will apply either of the above values as the case may be. Otherwise, the lowest values shall be used for conservativeness.
Purpose of data:	Calculation of baseline emissions
Additional comment:	-

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North America: For breeding swine 0.48, for market swine 0.48¶
Eastern Europe: For breeding swine 0.45, for market swine 0.45¶
Western Europe: For breeding swine 0.45, for market swine 0.450.45

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[8] Breeding Swine, Department of Livestock Development www.dld.go.th

Data / Parameter:	$VS_{LT,y}$
Data unit:	Kg dm/animal/year
Description:	Volatile solids for livestock "LT" entering the animal manure management system in year "y"
Source of data:	2006 IPCC Guidelines for National Greenhouse Gas Inventories Annex 10A.2 Tables 10A-7 and 10A-8
Value(s) applied:	

Region	Breeding swine	Market swine
North America	0.5	0.27
Western Europe	0.46	0.3
Eastern Europe	0.5	0.3
Oceania	0.5	0.28
Latin America	0.3	0.3
Africa	0.3	0.3
Middle East	0.3	0.3
Asia	0.3	0.3
Indian Subcontinent	0.3	0.3

Choice of data or Measurement methods and procedures:	Reference from AMS-III.D Version 18, Paragraph 10. Country specific value is not available in Thailand. Therefore, IPCC default values provided in 2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 4 chapter 10 table 10 A-4 to 10 A-9 can be used. The chosen values for eastern European breed were applied in the baseline calculations as the swine breed and fattened in the participating farms are of Eastern European origin.[9] For baseline emissions each farm will apply either of the above values as the case may be. Otherwise, the lowest values shall be used for conservativeness.
Purpose of data:	Calculation of baseline emissions
Additional comment:	-

Data / Parameter:	**Flare Efficiency (FE)**
Data unit:	%
Description:	The fraction of methane destroyed. The flare efficiency is defined as the fraction of time in which the gas is combusted in the flare, multiplied by the efficiency of the flaring process.
Source of data:	*Tool to determine project emission from flaring gases containing methane*
Value(s) applied:	50%
Choice of data or Measurement methods and procedures:	For open flare 50% default value should be used, as it is not possible in this case to monitor the efficiency.
Purpose of data:	Calculation of project emissions
Additional comment:	-

[9] Breeding Swine, Department of Livestock Development www.dld.go.th

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Western Europe: For breeding swine 0.46, for market swine 0.3¶
Eastern Europe: For breeding swine 0.5, for market swine 0.3¶
Oceania: For breeding swine 0.5, for market swine 0.28¶
Latin America: For breeding swine 0.3, for market swine 0.3¶
Africa: For breeding swine 0.3, for market swine 0.3¶
Middle East: For breeding swine 0.3, for market swine 0.3¶
Asia: For breeding swine 0.3, for market swine 0.3¶
Indian Subcontinent: For breeding swine 0.3, for market swine 0.3North America: For breeding swine 0.5, for market swine 0.27¶
Eastern Europe: For breeding swine 0.5, for market swine 0.3¶
Western Europe: For breeding swine 0.46, for market swine 0.3

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Data / Parameter:	CEF_{grid}
Data unit:	tCO_2/MWh
Description:	Emission coefficient of the electricity distribution system
Source of data:	Office of Energy Policy and Planning (http://www.eppo.go.th) Electricity Generating Authority of Thailand (http://www.egat.co.th) Department of Alternative Energy Development and Efficiency (http://dede.go.th)
Value(s) applied:	0.5661
Choice of data or Measurement methods and procedures:	Calculated according to the tool to calculate emission, using publicly available statistic data published by Ministry of Energy. Simple OM has been calculated for national grid; given the low-cost/must-run resources constitute less than 50% of the total grid generation in average of the five most recent years. The calculation of BM for both grids is based on the five power plants that have been built most recently.
Purpose of data:	Calculation of baseline emissions
Additional comment:	Computations of grid CEFs is shown in Appendix 4

Data / Parameter:	$w_{CH4,y}$
Data unit:	%
Description:	Methane content in biogas in the year "y" on a dry basis (mass fraction)
Source of data:	AMS-III.D Version 18,Table III.D.1
Value(s) applied:	60
Choice of data or Measurement methods and procedures:	Reference from AMS-III.D Version 18, Table III.D.1. As per the methodology, the option chosen for this project activity is to use the default value.
Purpose of data:	Calculation of project emissions
Additional comment:	-

B.6.3. Ex-ante calculations of emission reductions

Ex ante emission reductions of the project activity are calculated as explained in section B.6.1. Therefore:
Farm:_____

Table B.6.3.1: Volatile Solid value for Farm _____

$VS_{default}$	$W_{default}$	Kg VS/head/day	W_{site} (kg)	Kg $VS_{default}$/head/day	Kg $VS_{default}$/head/year
Breeding (male)	180	0.45	0	0.00	0.00
Breeding (female)	180	0.5	0	0.00	0.00
Pregnant sow	180	0.5	0	0.00	0.00
Fattening 2	50	0.3	0	0.00	0.00
Fattening 1	50	0.3	0	0.00	0.00
Nursery	50	0.3	0	0.00	0.00
Farrow	50	0.3	0	0.00	0.00

Table B.6.3.2: Baseline emission for Farm_____

Type of animal	$N_{da,y}$ no. of days alive in the farm (day)	$N_{p,y}$ Annual Production (no.)	$VS_{LT,y}$	$N_{LT,y}$	CH_4 production for each type of animal	$BE_{LT,y}$
Breeding (male)						
Breeding (female)						
Pregnant sow						
Fattening 2						
Fattening 1						
Nursery						
Farrow						
(other type, any)						

Project Activity Emission Reduction

I. Emissions due to physical leakage of biogas in year "y" (tCO_2e) for Farm _____

Type of animal	Amount of CH4 leaked	Project Emissions due to physical leakage (tCO_2e)
Breeding (male)		
Breeding (female)		
Pregnant sow		
Fattening 2		
Fattening 1		
Nursery		
Farrow		
(other type, any)		

II. Methane Emission from flaring for Farm _____

PE flare,y		tCO_2e/y		**Amount of Biogas (m^3)**
Flare Efficiency		Open flare	Produce(m^3/d)	
Amount of Biogas send to flare		m^3/day	Electricity	
Biogas Methane content			Utilization	
Number of operation day		days/year		
Density of CH_4		kg/m^3		

III. Project emissions from electricity consumption in year y for Farm _____

$PE_{EC,y}$		tCO_2e/y
Amount of Electricity Consumed		kWh/year

Grid Emission Factor		tCO_2e/MWh
TDL		-

Summary of Annual Emission Reduction for the CPA

Year	Estimation of baseline emissions (tonnes of CO_2 e)	Estimation of project activity emissions (tonnes of CO_2 e)	Estimation of leakage (tonnes of CO_2 e)	Estimation of overall emission reductions (tonnes of CO_2 e)
Year 1				
Year 2				
Year 3				
Year 4				
Year 5				
Year 6				
Year 7				
Total for crediting period (tonnes of CO_2 e)				

* The first year, starts by the expected date of inc;usion under the PoA, therefore the crediting period ends seven years after. For complete details please refer to emission reduction calculation spreadsheet.

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

B.7.1. Data and parameters to be monitored by each generic CPA

Data / Parameter:	$N_{LT,y}$
Data unit:	Number
Description:	Number of animals produced annually of type *LT* for the year *y*
Source of data:	Participating Farm
Value(s) applied:	

Type of animal	Farm [X]	Farm [Y]
Breeding (male)		
Breeding (female)		
Fattening 1		
Fattening 2		
Nursery		
TOTAL		

Measurement methods and procedures:	The average number of animals per animal category is calculated monthly based on each farms records on logbooks for the farms operations. Monthly records of animal comprise: entries (purchase; births, internal transfer) and exit (ex: sale, death, internal transfer) and the final monthly record of animals.
Monitoring frequency:	To be recorded monthly and aggregated and reported annually.
QA/QC procedures:	The farms records in the logbooks will be crosschecked by ERDI to guarantee consistency; animal purchase and sale records are used to cross-check the information reported
Purpose of data:	Calculation of baseline emissions
Additional comment:	Data will be kept for two years after the end of the crediting period

Data / Parameter:	$N_{da,y}$
Unit:	Number

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Description:	Number of days animal is alive in the farm in the year *y*
Measured / Calculated / Default:	Measured
Source of data:	Farm record
Value(s) of monitored parameter:	Please see explanation in data/parameter $N_{LT,y}$
Monitoring equipment:	N/A
Measuring / Reading / Recording frequency:	
Calculation method (if applicable):	
QA/QC procedures:	
Purpose of data:	
Additional comment:	The calculation of the average number of animals (NLT,y) is done monthly based on each farms internal records filled in by farm manager or assigned personnel. It presents the records of animal entries (purchase; births, internal transfer) and exit (ex: sale, death, internal transfer) and the final monthly record of animals per animal category (ex: nursery, farrow, fattening 1 and fattening 2, breeding male, breeding female, pregnant sow).Using this approach for calculating NLT,y, it is not necessary to calculate separately an Nda,y and Np,y, since the number of days the animal are alive (Nda,y) and the number of animals produced per category LT (Np,y) are already implicitly considered in the monthly records and taken into account when calculating NLT,y. The farms internal records with weekly logs are then the input for the emission reduction calculation spreadsheet and aggregates the monthly average number of animals per animal category per farm for all farms included in the DDs .

Data / Parameter:	$N_{p,y}$
Unit:	Number
Description:	Number of animals produced annually of type *LT* for the year *y*
Measured / Calculated / Default:	Measured
Source of data:	Participating Farm
Value(s) of monitored parameter:	Please see explanation in data/parameter $N_{LT,y}$
Monitoring equipment:	N/A
Measuring / Reading / Recording frequency:	
Calculation method (if applicable):	
QA/QC procedures:	
Purpose of data:	
Additional comment:	The calculation of the average number of animals ($N_{LT,y}$) is done monthly based on each farms internal records filled in by farm manager or assigned personnel. It presents the records of animal entries (purchase; births, internal transfer) and exit (ex: sale, death, internal transfer) and the final monthly record of animals per animal category (ex: nursery, farrow, fattening 1 and fattening 2, breeding male, breeding female, pregnant sow).Using this approach for calculating $N_{LT,y}$, it is not necessary to calculate separately an $N_{da,y}$ and $N_{p,y}$, since the number of days the

	animal are alive ($N_{da,y}$) and the number of animals produced per category *LT* ($N_{p,y}$) are already implicitly considered in the monthly records and taken into account when calculating $N_{LT,y}$. The farms internal records with weekly logs are then the input for the emission reduction calculation spreadsheet and aggregates the monthly average number of animals per animal category per farm for all farms included in the DDs.

Data / Parameter:	**W_{site}**
Data unit:	Kg
Description:	Average animal weight of a defined livestock population at the project site
Source of data:	Farm records of animal average weight in each category in the farm annually
Value(s) applied:	

Type of animal	Farm [X]	Farm [Y]
Breeding (male)		
Breeding (female)		
Fattening 1		
Fattening 2		
Nursery		
TOTAL		

Measurement methods and procedures:	Farm records of animal average weight using a scale in each category in the farm. Sampling procedures can be used to estimate this variable as per the "Standard for Sampling and Surveys for CDM Project Activities and Programme of Activities", version 02.0.
Monitoring frequency:	Aggregated and reported annually
QA/QC procedures:	Farm manager's signature is required on the record. The scale is calibrated according to the national standards and recalibrated at appropriate intervals according to manufacturer specifications, but at least once in three years.
Purpose of data:	Calculation of baseline emissions
Additional comment:	Data will be kept for two years after the end of the crediting period

Data / Parameter:	**$BG_{burnt,y}$**
Data unit:	Nm^3
Description:	Biogas volume in year *y*
Source of data:	Flow meters
Value(s) applied:	XXX
Measurement methods and procedures:	The total amount of biogas collected shall be determined by the sum of the monitored amount of biogas supplied to generator ($BG_{elec,y}$) and the amount of biogas sent to the flaring system ($BG_{flare,y}$). The measurement method of each parameter can be referred to the relevant parameter table below.
Monitoring frequency:	The gas flared and used will be monitored continuously with an accumulated volume recording (e.g. hourly/daily accumulated reading)
QA/QC procedures:	Please refer to relevant parameter table
Purpose of data:	Calculation of baseline emissions
Additional comment:	Data will be kept for two years after the end of the crediting period

Data / Parameter:	$BG_{elec,y}$
Data unit:	Nm^3
Description:	Amount of biogas captured and used as fuel for the generator
Source of data:	Flow meter
Value(s) applied:	XXX
Measurement methods and procedures:	The biogas flow meter shall be the equivalent of Orifice Plate or better with 95% accuracy. The meter will take into account the temperature and pressure of the biogas generated to provide accurate reading in Normal Cubic Meter (Nm^3). Data will be aggregated monthly and reported annually.
Monitoring frequency:	Biogas used by the generator will be monitored continuously through the use of biogas flow meter at each farm every day.
QA/QC procedures:	Flow meters are to be periodically calibrated according to the manufacturer's recommendation. For example the ST51 Mass Flow meter from Fluid Component International LLC will be calibrated every 18 months.
Purpose of data:	Calculation of baseline emissions
Additional comment:	At pressure 1 atm, 20 degree Celsius. Data will be kept for two years after the end of the crediting period

Data / Parameter:	$BG_{flare,y}$
Data unit:	Nm^3
Description:	Amount of biogas sent to flare
Source of data:	Flow meter
Value(s) applied:	XXX
Measurement methods and procedures:	The biogas flow meter shall be the equivalent of Orifice Plate or better with 95% accuracy. The meter will take into account the temperature and pressure of the biogas generated to provide accurate reading in Normal Cubic Meter (Nm^3). Data will be aggregated monthly and reported annually.
Monitoring frequency:	Biogas sent to flare will be monitored continuously through the use of biogas flow meter at each farm every day.
QA/QC procedures:	Flow meters are to be periodically calibrated according to the manufacturer's recommendation. For example the ST51 Mass Flow meter from Fluid Component International LLC will be calibrated every 18 months.
Purpose of data:	Calculation of project emissions
Additional comment:	At pressure 1 atm, 20 degree Celsius. Data will be kept for two years after the end of the crediting period

Data / Parameter:	**Flare operation**
Data unit:	hours
Description:	Flare operation in hour *h*
Source of data:	Measurements by project participants
Value(s) applied:	Not applicable
Measurement methods and procedures:	A flame detector will indicate when the flare is operating or not.
Monitoring frequency:	Continuous
QA/QC procedures:	Flame detector will be operated and maintained as per manufacturer specifications
Purpose of data:	Calculation of project emissions
Additional comment:	As per the "*Tool to determine project emissions from flaring of gases containing methane*", since CPAs will use open flares, when the flare

	is operating a default value at 50% will be used for the flare efficiency. Data will be kept for two years after the end of the crediting period

Data / Parameter:	**EC_{PJy}**
Data unit:	kWh
Description:	Quantity of electricity consumed by the project from the grid
Source of data:	Electricity meter recording
Value(s) applied:	0
Measurement methods and procedures:	Farm record on the electricity on-site consumption from the grid.
Monitoring frequency:	Continuous
QA/QC procedures:	Farm manager's signature is required on the record. The calibration of the electricity meter, owned by the national electricity authority, shall be requested by the CME/farm owner to be conducted at appropriate intervals according to manufacturer specifications, but at least once in three years.
Purpose of data:	Calculation of project emissions
Additional comment:	Only monitored if the farm consumes electricity from the grid For ex-ante calculations this parameter is assumed to be 0. If monitoring of electricity consumed by the project cannot be isolated from the overall farm electricity consumption, EC_{PJy} will be derived from applying the assumption that electrical appliances are continuously utilized, and a corresponding value applied. Data will be kept for two years after the end of the crediting period

Data / Parameter:	**$EG_{y,Auxillairy}$**
Data unit:	kWh
Description:	Renewable electricity generated by the project activity, consumed by auxiliary equipment
Source of data:	Farm record on the utilization of electrical appliances under the project activity, using renewable energy
Value(s) applied:	0
Measurement methods and procedures:	Farm record on the utilization of electrical appliances under the project activity.
Monitoring frequency:	Monthly and aggregated annually
QA/QC procedures:	Farm manager's signature is required on the record
Purpose of data:	Calculation of project emissions
Additional comment:	For ex-ante calculations this parameter is assumed to be 0 If recovered methane is used to power auxiliary equipment of the project it should be taken into account accordingly, using zero as its emission factor. Data will be kept for two years after the end of the crediting period

Data / Parameter:	**$FC_{i,j,y}$**
Data unit:	m^3/yr
Description:	Onsite combustion of fossil fuels of type *i* in process *j* during the year y
Source of data:	Project Implementer
Value(s) applied:	0
Measurement methods and procedures:	Volumetric meter will be employed to measure the fossil fuel consumption continuously as per the "*Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion*" *version 02*. There will be a book of control for recording the measurements.
Monitoring frequency:	Monthly and aggregated annually
QA/QC procedures:	The consistency of metered fuel consumption quantities will with available purchase invoices from the financial records.
Purpose of data:	Calculation of project emissions
Additional comment:	For ex-ante calculations this parameter is assumed to be 0 Required to calculate project emissions from fossil fuel combustion. Data will be kept for 2 years after end of crediting period.

Data / Parameter:	**$NCV_{i,y}$**
Data unit:	GJ/m^3
Description:	Net calorific value of fuel type *i* in year *y*
Source of data:	Values from the fuel supplier will be used.
Value(s) applied:	Only used in ex-post calculations
Measurement methods and procedures:	Values provided by the fuel supplier. Undertaken in line with national or international fuel standards.
Monitoring frequency:	The NCV will be obtained for each fuel delivery, from which weighted average annual values should be calculated.
QA/QC procedures:	Values will be verified to check that they are within the uncertainty range of the IPCC default values as provided in Table 1.2, Vol. 2 of the 2006 IPCC Guidelines. If the values fall below this range collect additional information from the testing laboratory to justify the outcome or conduct additional measurements.
Purpose of data:	Calculation of project emissions
Additional comment:	Only to be monitored by CPAs where fossil fuel use is expected. Data will be kept for 2 years after end of crediting period or last issuance of CERs for the project activity.

Data / Parameter:	**$EF_{CO2,i,y}$**
Data unit:	tCO_2/GJ
Description:	CO_2 emission factor of fuel type *i* in year y
Source of data:	If there are no values provided by the fuel supplier, IPCC default values should be used: at the upper limit of the uncertainty at a 95% confidence interval as provided in table 1.4 of chapter 1 of Vol 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories (there is no available data from the fuel supplier).
Value(s) applied:	Only used in ex-post calculations
Measurement methods and procedures:	-
Monitoring frequency:	
QA/QC procedures:	It will be checked against any future revision of IPCC Guidelines
Purpose of data:	Calculation of project emissions
Additional comment:	Only to be monitored by CPAs where fossil fuel use is expected.

	Data will be kept for two years after the end of the crediting period

Data / Parameter:	**$MS\%_{i,y}$**
Data unit:	%
Description:	Fraction on manure handled in system *i* in the project activity in year *y*
Source of data:	Farm records
Value(s) applied:	100
Measurement methods and procedures:	All manure is expected to be processed in the digesters. Should any manure be diverted, the weight will be measured using a scale.
Monitoring frequency:	A monthly confirmation that all waste is handled in the treatment system will be recorded in the farms logbook.
QA/QC procedures:	Farm manager's signature is required on the record. The scale is calibrated according to the national standards and recalibrated at appropriate intervals according to manufacturer specifications, but at least once in three years.
Purpose of data:	Calculation of baseline emissions
Additional comment:	For ex-ante calculations it is assumed that 100% of the waste will be treated by the new treatment system. Data will be kept for two years after the end of the crediting period

Data / Parameter:	**nd_y**
Data unit:	Days
Description:	Number of days that the animal manure management system was operational
Source of data:	Farm record
Value(s) applied:	365
Measurement methods and procedures:	The record on the number of days in year *y* where the treatment plant was not operational will be documented in a logbook and taken into account for the calculation of BEex-post.
Monitoring frequency:	To be monitored monthly based on daily records, and reported annually.
QA/QC procedures:	Farm manager's signature is required on the record
Purpose of data:	Calculation of baseline emissions
Additional comment:	Data will be kept for two years after the end of the crediting period

Data / Parameter:	**Proper soil application (not resulting in methane emissions) of the residual waste**
Data unit:	%
Description:	Ratio of final sludge treated aerobically over total sludge treated.
Source of data:	Farm record of final sludge treated aerobically and sludge treated anaerobically.
Value(s) applied:	100
Measurement methods and procedures:	Farm record of final sludge treated aerobically and sludge treated anaerobically.
Monitoring frequency:	Monthly
QA/QC procedures:	Farm manager's signature is required farm data record sheet
Purpose of data:	Calculation of project emissions
Additional comment:	For ex-ante calculations this parameter is assumed to be 100 Data will be kept for two years after the end of the crediting period

Data / Parameter:	Onsite inspections for each individual farm included in the project boundary
Data unit:	Not applicable
Description:	Onsite inspections of the project boundary
Source of data:	Farm monitoring record data
Value(s) applied:	Not applicable
Measurement methods and procedures:	Regular farm inspections to check that the equipments are working properly, maintenance are perform according to manufacturer's specification, and all monitoring data is recorded as required in the monitoring data record sheet.
Monitoring frequency:	Annually
QA/QC procedures:	Farm's manger signature is required on the monitoring data record sheet.
Purpose of data:	Calculation of baseline and project emissions
Additional comment:	

Data / Parameter:	Genetic source of the production operations livestock
Data unit:	Not applicable
Description:	Genetic source of the production operations livestock
Source of data:	Farm monitoring record data
Value(s) applied:	Oceania, North America, Western Europe or Eastern Europe, Latin America, Africa, Middle East, Asia or Indian Subcontinent
Measurement methods and procedures:	Farm records
Monitoring frequency:	Annually
QA/QC procedures:	Farm's manger signature is required on the monitoring data record sheet.
Purpose of data:	Calculation of baseline emissions
Additional comment:	Data will be kept for two years after the end of the crediting period.

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Deleted: to prove that the livestock genetic source originates from an Annex I Party.of livestock from the possible region (as delineated in parameter tables B_o and $VS_{default}$)

Data / Parameter:	FFR
Data unit:	-
Description:	Formulated Feed Rations
Source of data:	Farm monitoring record data
Value(s) applied:	XXX
Measurement methods and procedures:	Farm records on FFR.
Monitoring frequency:	Annually
QA/QC procedures:	Farm's manager signature is required on the monitoring data record sheet.
Purpose of data:	Calculation of baseline emissions
Additional comment:	Data will be kept for two years after the end of the crediting period

Data / Parameter:	**$TDL_{j,y}$**
Data unit:	-
Description:	Average technical transmission and distribution losses for providing electricity to source *j* in year *y*
Source of data:	Ministry of Energy, "Electric Power in Thailand", 2011. Use recent, accurate and reliable data available in Thailand. http://www.dede.go.th/dede/images/stories/stat_dede/electric54_1.pdf
Value(s) applied:	6.30%
Measurement methods and procedures:	In the absence of data from the relevant year, most recent figures should be used, but not older than 5 years.
Monitoring frequency:	Annually
QA/QC procedures:	It would be checked against future revisions of *Electric Power in Thailand* published annually by the Department of Alternative Energy Development and Efficiency (DEDE), Ministry of Energy.
Purpose of data:	Calculation of project emissions
Additional comment:	Data will be kept for two years after the end of the crediting period

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B.7.2. Description of the monitoring plan for a generic CPA

Monitoring will be implemented according to the monitoring plan to ensure that the real, measurable and long-term GHG emission reductions for the project activity are monitored and reported accordingly. The emission reductions achieved by the project activity will be determined ex-post through direct measurement of the amount of methane fuelled, flared or gainfully used. It is likely that the project activity involves manure treatment steps with higher methane conversion factors (MCF) than the MCF for the manure treatment systems used in the baseline situation, therefore the emission reductions achieved by the project activity is limited to the ex-post calculated baseline emissions minus project emissions using the actual monitored data for the project activity ($N_{LT,y}$, $MS\%_{i,y}$ and in case adjusted values for animal weight are used as defined in paragraph 10 (c): $VS_{LT,y}$).

The emission reductions achieved in any year are the lowest value of the following:

$$ER_{y,ex\text{-}post} = min[(BE_{y,ex\text{-}post} - PE_{y,ex\text{-}post}),(MD_y - PE_{power,y,ex\text{-}post})]$$

Where:

$ER_{y,ex\text{-}post}$: Emission reductions achieved by the project activity based on monitored values for year "y" (tCO_2e)

$BE_{y,ex\text{-}post}$: Baseline emissions calculated using formula 1 using ex post monitored values of $N_{LT,y}$ and if applicable $VS_{LT,y}$

$PE_{y,ex\text{-}post}$: Project emissions calculated using formula 4 using ex post monitored values of $N_{LT,y}$, $MS\%_{i,y}$ and if applicable $VS_{LT,y}$

MDy: Methane captured and destroyed or used gainfully by the project activity in year "y" (tCO_2e)

$PE_{power,y,ex\text{-}post}$: Emissions from the use of fossil fuel or electricity for the operation of the installed facilities based on monitored values in the year "y" (tCO_2e)

In case of flaring/combustion MD_y will be measured using the conditions of the flaring process:

$$MD_y = BG_{burnt,y} * w_{CH4,y} * D_{CH4} * FE * GWP_{CH4}$$

Where:
$BG_{burnt,y}$: Biogas flared or combusted in year "y" (m^3)
$w_{CH4,y}$: Methane content in biogas in the year "y" (mass fraction)
FE: Flare efficiency in the year "y" (fraction)

Alternatively, if project activities utilize the recovered methane for power generation, $MD_{,y}$ may be calculated as follows, based on the amount of monitored electricity generation, without monitoring methane flow and concentration.

$$MD_y = \frac{EG_y \times 3600}{NCV_{CH4} \times EE_y} \times D_{CH4} \times GWP_{CH4}$$

Where:

EG_y = Total electricity generated from the recovered biogas in year *y* (MWh)

3600 = Conversion factor (1 MWh = 3600 MJ)

NCV_{CH4} = NCV of methane (MJ/Nm^3) use default value: 35.9 MJ/Nm^3)

EE_y = Energy conversion efficiency of the project equipment, which is determined by adopting one of the following criteria:

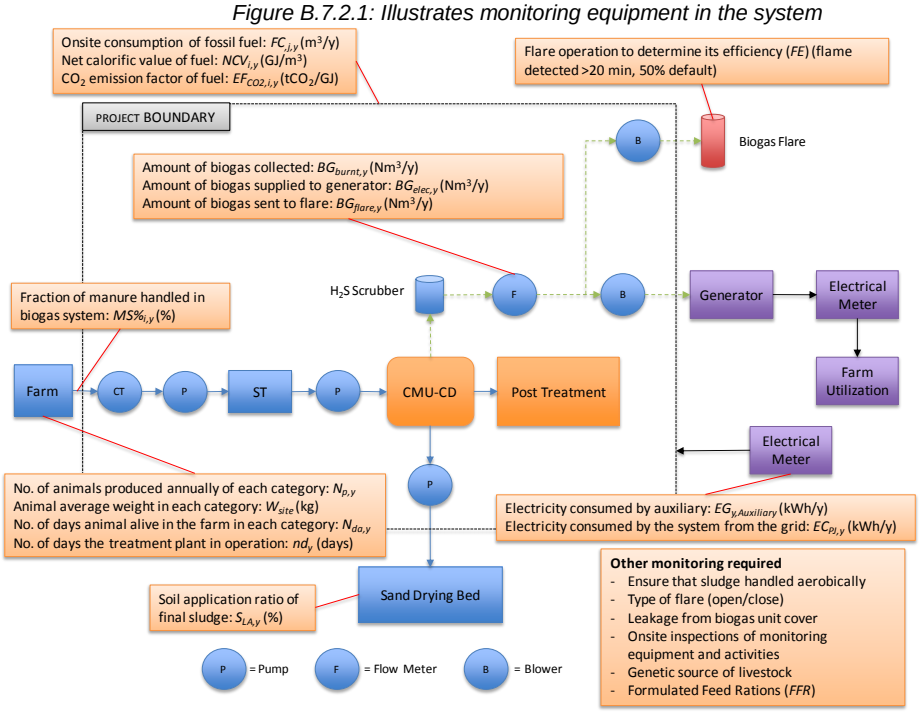
- Specification provided by the equipment manufacture. The equipment shall be designed to utilize biogas as fuel, and efficiency specification is for this fuel. If the specification provides a range of efficiency values, the highest value of the range shall be used for the calculation;
- Default efficiency of 40 %

Project proponents shall provide evidence to the DOE that only the biogas recovered through the project manure management system is used for power generation; no other gas or fuels except a start-up fuel[10] are used.

1. What is required by the monitoring plan?

[10] If a fuel is defined as a start-up fuel, it should not represent more than 1% of the total fuel utilized in the process, on energy basis.

Figure B.7.2.1: Illustrates monitoring equipment in the system



The biogas flow and methane content will be monitored on the same wet basis.

2. Who uses the monitoring plan?

ERDI will be responsible for coordinating the farm owners, providing technical service including organizing training to farmers involved, supervising the project implementation, as well as to organize technical support team to carry out the monitoring of the project implementation. The monitoring plan will be implemented as per the registered PoA in order to ensure that the monitoring process is credible, transparent and conservative.

More specifically, the ERDI will be responsible for collecting the monitoring data and drafting the monitoring report by working with the farm owners.

3. **Monitoring**

To ensure reliable field measurements and data collection quality, the following procedures should be followed for quality control:

- Standard operating procedures for the field measurements, including a) detailed processes for each element measured, and b) provisions for documentation for verification purposes, are provided in the CMU-CD operation manual in Thai)
- The procedures for emergency preparedness for cases where emergencies can cause unintended emissions and also the risk of fire on emergency condition; Procedure for the registration, monitoring, measurement and reporting procedure needs to be provided; and Corrective actions procedures in order to provide for more accurate future monitoring and reporting; are attached in Annex 4 and provided in CMU-CD operation manual.
- Training courses on field data collection and data analyses will be held for staff involved in the field measurement work.
- The list of the names of the field team and project leader who join the training and

monitoring process will be filed accordingly.

- Any new staff will be trained adequately.

ERDI will be responsible for archiving data electronically and in printed form, for monitoring report preparation. Such data will be available until 2 years after the Project Activity has ended for comparison and analysis by the verifier. The data from monitoring report will be imported to excel sheets where equations of the methodology are integrated for the year.

Appendix 1. Contact information of coordinating/managing entity and responsible person(s)/ entity(ies)

CME and/or responsible person/ entity	☒ CME ☒ Responsible person/ entity for application of the selected methodology(ies) and, where applicable, the selected standardized baseline(s) to the PoA
Organization	Energy Research and Development Institute – Nakornping of Chiang Mai University
Street/P.O. Box	239 Huaykaew Rd.
Building	Chiang Mai University.
City	Suthep
State/Region	Chiang Mai
Postcode	50202
Country	Thailand
Telephone	+66-5394-2007
Fax	+66 5390-3763
E-mail	Praert.134@gmail.com
Website	www.erdi.or.th
Contact person	Director
Title	Associate Professor
Salutation	-
Last name	Rerkkriangkrai
Middle name	-

CME and/or responsible person/ entity	☐ CME ☐ Responsible person/ entity for application of the selected methodology(ies) and, where applicable, the selected standardized baseline(s) to the PoA
Organization	International Bank for Reconstruction and Development as Trustee of the Carbon Fund for Europe
Street/P.O. Box	1818 H Street, NW
Building	MC
City	Washington
State/Region	District of Columbia
Postcode	20433
Country	United States
Telephone	1 202 458 1873
Fax	1 202 522 7432
E-mail	IBRD-carbonfinance@worldbank.org
Website	www.carbonfinance.org
Contact person	
Title	
Salutation	
Last name	
Middle name	

CME and/or responsible person/ entity	☐ CME ☐ Responsible person/ entity for application of the selected methodology(ies) and, where applicable, the selected standardized baseline(s) to the PoA
Organization	Government of Portugal – Portuguese Carbon Fund
Street/P.O. Box	Rua da Murgueira, 9/9A, Apartado 7586, Zambujal, Alfragide
Building	-
City	Amadora
State/Region	-
Postcode	2611-865
Country	Portugal
Telephone	+351-21-470-9920
Fax	+351-21-471-9076
E-mail	nuno.lacasta@apambiente.pt
Website	-
Contact person	Nuno Lacasta
Title	Manager of the Portuguese Carbon Fund
Salutation	Mr.
Last name	Lacasta
Middle name	-

Appendix 2. Affirmation regarding public funding

There is no diversion of ODA for the project.

Appendix 3. Applicability of methodology(ies) and standardized baseline(s)

The approved baseline and monitoring methodology applied for a typical SSC-CPA is *AMS III. D Methane recovery in animal manure management systems*, version 18.

Appendix 4. Further background information on ex ante calculation of emission reductions

Grid Emission Factor 2008

The emission factor was calculated based on the "*Tool to calculate the emission factor for an electricity system*" – Version 02.2.1.

The latest data available for the calculation of emission reduction prior to the stakeholder consultation is 2008.

Step 1: Identify the relevant electricity systems

The relevant electric power system for the project is Thailand national grid. The DNA has not published a delineation of the project electricity system.

Step 2: Choose whether to include off-grid power plants in the project electricity system (optional)

(a) This optional step is not undertaken thus Option 1 is selected (i.e., Option I: Only grid power plants are included in the calculation; Option I corresponds to the procedure contained in earlier versions of this Tool).

Step 3: Select a method to determine the operating margin (OM) The calculation of the operating margin emission factor is based on (a) Simple OM. This method is selected because the low cost must run resources constitute less than 50% on average of the five most recent years.

Year	Hydro	Fuel Oil	Diesel Oil	Coal & Lignite	Natural Gas	Others (RE)	Total	% low cost must run
2004	6,040	7,138	551	17,993	80,489	2	112,213	5%
2005	5,798	8,244	414	18,334	85,703	2	118,495	5%
2006	8,125	8,350	143	22,051	86,339	3	125,011	7%
2007	8,114	3,646	174	28,716	88,166	3	128,819	6%
2008	7,113	1,454	180	29,480	94,549	5	132,781	5%

Source: Table 17 National Grid Generation by Energy Sources, Electric Power in Thailand 2008, (DEDE), http://www2.dede.go.th/km_berc/downloads/menu2/รายงานประจำปี%202547-2551/การใช้พลังงานไฟฟ้าของประเทศ/Elec_2551.pdf

The table above shows that the percentage of low cost must run resources from 2004-2008 are less than 50%. Hence Simple OM method is selected.

The ex ante option is selected, the emission factor is determined once at the validation stage, thus no monitoring and recalculation of the emissions factor during the crediting period is required.

Step 4: Calculate the operating margin emission factor according to the selected method

The calculation is based on the fuel type, total fuel consumption and the total net electricity generation (Option B of the Tool) for three consecutive years (using the latest available data at the time of the publication of the PDD for stakeholder comments, i.e., 2006, 2007, 2008).

Option B can be selected in this case because: the necessary data for Option A is not available and Option I has been chosen in Step 2.

$$EF_{grid,OMsimple,y} = \frac{\sum_i \left(FC_{i,y} \times NCV_{i,y} \times EF_{CO2,i,y}\right)}{EG_y}$$

Where:

$EF_{grid,OMsimple,y}$ = Simple operating margin CO_2 emission factor in year *y* (tCO_2/MWh)

$FC_{i,m,y}$ = Amount of fossil fuel type i consumed in the project electricity system in year y (mass or volume unit)

$NCV_{i,y}$ = Net Calorific value (energy content) of fossil fuel type *i* in year *y* (GJ / mass or volume unit)

$EF_{CO2,i,y}$ = CO_2 emission factor of fossil fuel type i in year y (tCO_2/GJ)

$EG_{m,y}$ = Net electricity generated and delivered to the grid by all power sources serving the system, not including low-cost / must-run power plants / units, in year *y* (MWh)

i = All fossil fuel types combusted in power sources in the project electricity system in year *y*

y = The relevant year as per the data vintage chosen in Step 3.

Data for Simple OM calculation:

EGAT's grid generation and fuel consumption data 2006-2008.

Type of Fuel	Source	Unit	2008	2007	2006
Hydro	Total	Gwh	7,113	8,114	8,125
Emission		tCO2	0	0	0
Natural Gas	Total	GWh	94,549	88,166	86,339
Amount of Fuel use	Annually	MMscf	907,327	783,137	857,103
Emission		tCO2	50,253,213	43,374,826	47,471,507
Fuel Oil	Total	GWh	1,454	3,646	8,350
Amount of Fuel use		Ml.	358	936	2,030
Emission		tCO2	1,074,943	2,810,466	6,095,349
Diesel	Total	GWh	180	174	143
Amount of Fuel use		Ml.	45	23	41
Emission		tCO2	118,984	60,814	108,408
Lignite	EGAT	GWh	29,480	28,716	22,051
Amount of Fuel use		Mt.	21	20	17
Emission		tCO2	26,732,617	24,506,458	21,408,543
Imported Power		Gwh	2,785	4,491	5,159
Emission			0	0	0
Total Generating	**Total**	**GWh**	**135,561**	**133,307**	**130,167**
Total Emission	**Total**	**tCO2**	**78,179,758**	**70,752,565**	**75,083,806**
Grid Emission Factor		**tCO2/MWh**	**0.5767**	**0.5307**	**0.5768**
				Average Grid Emission Factor	**0.5614**

Source: Electric Power in Thailand 2008 (DEDE).

Fuel Type	NCV[1] (MJ/unit)	Effective CO_2 emission Factor[2] (tCO2/TJ)	CO_2 emission per fuel unit (t/unit)	CO_2 emission coefficient	Unit
Natural Gas	1.02	54.3	5.54E-05	55.39	tCO_2/mscf
Fuel Oil	39.77	75.5	3.00E-03	3,002.64	tCO_2/mlitre
Diesel	36.42	72.6	2.64E-03	2,644.09	tCO_2/mlitre
Lignite[3]	13.72	90.9	1.25E-03	1,247,148	tCO_2/mt
Imported Coal[4]	26.37	89.5	2.39E-03	2,386,965	tCO_2/mt

Notes: 1 Electric Power in Thailand 2008 (DEDE), p. 42.

2 IPCC default values at the lower limit of the uncertainty at a 95% confidence interval as provided in table 1.4 of Chapter1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories

3 NCV of lignite is an average from 4 types of lignite. Source: Electric Power in Thailand 2008 (DEDE), page 42. http://www.dede.go.th/dede/fileadmin/upload/cc/EleThai110951.pdf

4 Applied CO_2 emission factor of Other Bituminous Coal from table 1.4 of 2006 IPCC Guidelines for conservativeness

Operating Margin = 0.5614[11]

Step 5: Calculate the build margin (BM) emission factor.

In terms of vintage of data, Option 1 is chosen. The build margin emission factor is determined by applying *ex-ante* option based on the most recent information available. Therefore, for the first crediting period, the build margin emission factor will be calculated *ex-ante* based on the most recent information available on units already built for sample group m at the time of CDM-PDD submission to the DOE for validation. For the second crediting period, the build margin emission factor should be updated based on the most recent information available on units already built at the time of submission of the request for renewal of the crediting period to the DOE. For the third crediting period, the build margin emission factor calculated for the second crediting period should be used. This option does not require monitoring the emission factor during the crediting period.

According to the Tool, the sample group of power units m used to calculate the build margin should be determined as per the following procedure, consistent with the data vintage selected above:

a) Identify the set of five power units, excluding power units registered as CDM Project activities, that started to supply electricity to the grid most recently ($SET_{5\text{-units}}$) and determine their annual electricity generation ($AEG_{SET\text{-}5\text{-}units}$, in GWh), as follows:

List of five most recently power plant units ($SET_{5\text{-units}}$) and their generation ($AEG_{SET\text{-}5\text{-}units}$, in GWh)

IPP	Fuel Type	Unit	Date of commissioning	Generation in 2008 (GWh)
Ratchburi Power	Natural gas	Unit 2	01-Jun-08	3,720
		Unit 1	01-Mar-08	
Gulf Power Generation Co., Ltd.	Natural gas	Unit 2	1-Mar-08	9,195
		Unit 1	5-May-07	
BLCP Power Limited*	Coal	Unit 2	14-Nov-06	5,400.5
Total				**19,922**

Source: The list of power plant is available at www.http://www.eppo.go.th/power/index.html and the generation data is from Table 8 of *Electric Power in Thailand 2008* (DEDE).

Remark: *The generation of BLCP is determined as per one unit from the total of two, or half of the plan's generation reported in *Electric Power in Thailand 2008* (DEDE).

b) Determine the annual electricity generation of the project electricity system, excluding power units registered as CDM project activities (AEG_{total}, in MWh). Identify the set of power units, excluding power units registered as CDM project activities, that started to supply electricity to the grid most recently and that comprise 20% of AEG_{total} (if 20% falls on part of the generation of a unit, the generation of that unit is fully included in the calculation) ($SET_{\geq 20\%}$) and determine their annual electricity generation ($AEG_{SET\text{-}\geq 20\%,}$ in GWh) as follows:

List of new power units recently supplying electricity to the grid that comprising 20% of annual electricity generation ($AEG_{SET\text{-}\geq 20\%,}$ in GWh)

IPP	Fuel Type	Unit	Date of commissioning	Generation in 2008 (GWh)
Ratchburi Power	Natural gas	Unit 2	01-Jun-08	3,720
		Unit 1	01-Mar-08	
Gulf Power Generation Co., Ltd.	Natural gas	Unit 2	01-Mar-08	9,195
		Unit 1	05-May-07	
BLCP Power Limited	Coal	Unit 2	14-Nov-06	10,801
		Unit 1	13-Aug-06	
Eastern Power & Electric Co., Ltd.	Natural gas		25-Mar-03	2,670

[11] For complete details please refer to the grid emission calculation spreadsheet

Glow IPP, Ltd.	Natural gas		31-Jan-03	5,146
Total				**31,532**

Source: The list of power plant is available at www.http://www.eppo.go.th/power/index.html and the generation data is from Table 8 of *Electric Power in Thailand 2008* (DEDE).

c) From $SET_{5\text{-units}}$ and $SET_{\geq 20\%}$ select the set of power units that comprises the larger annual electricity generation (SET_{sample});

The most recently built plants $SET_{\geq 20\%}$ have generated 31,532 GWh electricity representing 23.3% of the overall electricity generated by all power plants in the national grid in year 2008 while the set of five power units $SET_{5\text{-units}}$, excluding power units registered as CDM Project activities, that started to supply electricity to the grid most recently have generated 19,922 GWh. For the nation grid, the most recent capacity additions constituting 20% of the system represent a larger annual generation than the five most recently added power units, and is therefore chosen as the sample group for the build margin.

Therefore, since $SET_{\geq 20\%}$ is the set of power units that comprises the larger annual electricity generation, $SET_{\geq 20\%}$ is the SET_{sample}. Provided that 20% falls on part of the power generation of Glow IPP power plant, Glow IPP power plant is therefore fully included in the calculation as per the "*Tool to Calculate the Emission Factor for an Electricity System*" – version 02.2.1). The most recent capacity additions representing 20% of the system comprise larger annual generation than the five most recent plants, and are therefore the chosen as the build margin sample group as $SET_{sample\text{-}CDM}$. Steps (e) and (f) are ignored.

The build margin emissions factor is the generation-weighted average emission factor (tCO2/MWh) of all power units *m* during the most recent year *y* for which power generation data is available, calculated as follows:

$$EF_{grid,BM,y} = \frac{\sum_{i,m} EG_{m,y} * EF_{EL,m,y}}{\sum_{m} EG_{m,y}}$$

Where:

$EF_{grid,BM,y}$ = Build margin CO_2 emission factor in year *y* (tCO_2/MWh)
$EG_{m,y}$ = Net quantity of electricity generated and delivered to the grid in year *y* (MWh)
$EF_{EL,m,y}$ = CO_2 emission factor of fossil fuel type *I* in year y (tCO_2/MWh)
m = Power units included in the build margin
i = All fossil fuel types combusted in power plant / unit *m* in year *y*
y = Most recent historical year for which power generation data is available

Electricity generation efficiency in 2008

Power Plant/Company	Fuel Type	Efficiency (Btu/kWh)	Efficiency (TJ/GWh)	CO_2 emission* (tCO_2)
Ratchburi Power	Natural gas	9,287	9.79779	1,979,113
Gulf Power Generation Co., Ltd.	Natural gas	6,950	7.33225	3,660,908
BLCP Power Limited	Coal	9,100	9.60050	9,280,703
Eastern Power & Electric Co., Ltd.	Natural gas	6,811	7.18561	1,041,776
Glow IPP, Ltd.	Natural gas	6,910	7.29005	2,037,043
Total				**17,999,543**

Source: Plant efficiency data, in Btu/kWh, is from Table 18 of *Electric Power in Thailand 2008* (DEDE).
Remark: - CO_2 emission (tCO_2) is determined by Generation in 2008 (GWh) * Efficiency (TJ/GWh) * Effective CO_2 emission Factor (tCO_2/TJ) of fuel type.
- Effective CO_2 emission factors (tCO_2/TJ) of natural gas (54.3) and coal (89.5) are based on the IPCC default values at the lower limit of the uncertainty at a 95% confidence interval as provided in table 1.4 of Chapter1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories.

Build Margin = 0.5708[12]

Step 6. ***Calculate the combined margin emission factor***
The combined margin emissions factor is calculated as follows:
$EF_{grid,CM,y} = EF_{grid,OM,y} \times W_{OM} + EF_{grid,BM,y} \times W_{BM}$

Where:
$EF_{grid,CM,y}$ = Build margin CO_2 emission factor in year y (tCO_2/MWh)
$EF_{grid,OM,y}$ = Operating margin CO_2 emission factor in year *y* (tCO_2/MWh)
W_{OM} = Weighting of operating margin emissions factor (%)
W_{BM} = Weighting of build margin emissions factor (%)

As the project is category belong to other project W_{OM} = 0.5 and W_{BM} = 0.5 for the first crediting period.

Baseline Emission Factor for Thailand National Grid system in 2008

Margin	Weight	Emission Factor
OM	0.5	0.5614
BM	0.5	0.5708
Baseline		**0.5661**

Appendix 5. Further background information on the monitoring plan

(i) Description of the proposed statistically sound sampling method/procedure to be used by DOEs for verification of the amount of reductions of anthropogenic emissions by sources or removals by sinks of greenhouse gases achieved by SSC-CPAs under the PoA.

Step 1: Verification with the Designated National Authority to avoid double counting

The purpose of this step is to confirm with the DNA of the host country the validity of the boundary of the PoA and CPA. This will be checked with other PoA or CDM project activities undertaken by other project entities in the host country in order to avoid double counting.

Step 2: Interview with ERDI

ERDI will make available monitoring reports of all the SSC-CPAs to the Designated Operational Entity (DOE), detail of monitoring parameters are included in section E.7.2.

Step 3: Site visit

Reported number of participating farms
As the expected number of farms to join the PoA are not expected to surpass 30, and following the "*Standard for sampling and surveys for CDM project activities and programme of activities*", version 03.0. the PoA will not reach the minimum sample size as needed for a sampling plan. Thus no sample approach has been included for this PoA.

[12] For complete details please refer to the grid emission calculation spreadsheet

The DOE will then verify the monitoring report of the participating farms in the SSC-CPAs integrated to the PoA. The DOE will check the monitoring equipments installed at the farms, and data reported on the monitoring report. The list of monitoring parameters and meters installed is described in section E.7.2.

A transparent system is to be defined and described, that ensures that no double accounting occurs and that the status of verification can be determined anytime for each SSC-CPA.

Appendix 6. Summary of post registration changes

Version 14, dated 18/08/2016:

- Introduction of alternative values for parameters B_o and $VS_{LT,y}$ regarding instances where swine of different origin are used.

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Deleted: <#>Introduction of alternative way of calculating $N_{LT,y}$ based on practise followed at the participating farms.¶
<#>Clarification for calculation of quantity of electricity consumed by the project from the grid ($EC_{PJ,y}$)¶
<#>Update to version 4.0 of the PoA-DD template¶
<#>Alternative method for calculating MD,y introduced, following approved version 19.0 of the methodology.¶

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Document information

Version	*Date*	*Description*
05.0	15 April 2016	Revision to ensure consistency with the "Standard: Applicability of sectoral scopes" (CDM-EB88-A04-STAN) (version 01.0).
03.0	25 June 2014	Revisions to: • Include the Attachment: Instructions for filling out the programme design document form for small-scale CDM programme of activities (these instructions supersede the "Guideline: Completing the programme design document form for small-scale CDM programme of activities" (Version 03.0)); • Include provisions related to standardized baselines; • Add contact information on a responsible person(s)/ entity(ies) for the application of the methodology (ies) to the PoA in B.4 and Appendix 1; • Add general instructions on post-registration changes in paragraphs 2 and 3 of general instructions and **Error! Reference source not found.**; • Change the reference number from *F-CDM-SSC-PoA-DD* to *CDM-SSC-PoA-DD-FORM*; • Editorial improvement.
02.0	13 March 2012	EB 66, Annex 13 Revision required to ensure consistency with the "Guidelines for completing the programme design document form for small-scale CDM programmes of activities".
01.0	27 July 2007	EB33, Annex43 Initial adoption.

Decision Class: Regulatory
Document Type: Form
Business Function: Registration
Keywords: programme of activities, project design document, SSC project activities

Deleted: Appendix 6