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

CONTENTS

Annexes

Revision history of this document

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

SECTION A. General description of small-scale project activity

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

Project Title: Bangna Starch Wastewater Treatment and Biogas Utilization Project

PDD Version: 3.1*

Date: 25/09/2009

*PDD modified according to information provided in response to request for review by the CDM Executive Board on 11 September 2009.

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

Purpose of the project activity:
The proposed project activity consists of the installation of an upflow anaerobic sludge blanket technology (UASB) biogas reactor, tapioca pulp treatment and power generation (2.85 MW_{el} gas engine (3 X 0.95 MW) at an existing starch manufacturing plant for:

a) extraction of methane (biogas) from the wastewater stream through the biogas reactor, and
b) reuse of biogas as fuel for power generation (installed capacity of 2.85 MW_{el} gas engines).

The project replaces the existing wastewater treatment practice (open lagoon system) and thus avoids the release of methane into the atmosphere that results from the anaerobic digestion of the organic content in the wastewater treated in the lagoon system (anaerobic conditions, leading to methane generation within the lagoon are the result of lagoon depth (> 2m) and an average atmospheric temperature of about 28°C). The biogas reactor system is expected to handle a wastewater flow rate of 3,750m^3/day and an expected average COD concentration of 18.000 mg/l.

The biogas reactor produces sufficient quantities of biogas to fuel a number of gas engines for the production and sale to the electricity grid, thus displacing the production of power from fossil sources in the EGAT electricity grid. Therefore, the project activity will reduce green house gases due to avoidance of methane emissions from the existing lagoon system and displacement of fossil fuel based electricity from the grid.

The proposed project will be implemented by P&Papop Renewable Co. Ltd. on a BOOT (Build Own Operate Transfer) basis at the Yangthalat starch production facility of Bangna Tapioca Flour Co., Ltd. This means that P&Papop Renewable Co. Ltd. is responsible for arranging finance, constructing and operating the project. As the owner of the wastewater treatment plant, P&Papop Renewable Co. Ltd. will be the CDM project participant entitled to sell CERs.

Sustainable Development Benefits of the Project
The project will:

- As compared to common practice scenarios within the Tapioca industry that consist of open anaerobic lagoons, the project activity will minimize environmental impacts by cleaning the wastewater more efficiently, contributing to water conservation. Further, the Project will avoid odour emissions and pathogenic conditions as compared to an anaerobic lagoon, which contributes significantly to an improved life quality around the project site.

- The project activity contributes to technology transfer to Thailand within the starch producing sector
- The Project will generate direct jobs during the operation of the plant and temporary jobs during the construction of the plant
- The Project also contributes to the regional economic development. Apart from direct jobs during the construction and operation of the treatment plant, local firms will benefit from contracts during the construction, operation and maintenance of the plant, which supports regional economic development and creates indirect jobs.

ADDITIONAL REQUIREMENTS FOR THE GOLD STANDARD:
Sustainable Development Screen:

The project shows mainly positive scores according to the Gold Standard sustainability screen. For details please refer to the Annex 5.

A.3. Project participants:

Name of Party involved (*) ((host) indicates a host Party)	Private and/or public entity(ies) project participants (*) (as applicable)	Kindly indicate if the Party involved wishes to be considered as project participant (Yes/No)
Thailand (host)	P & Papop Renewable Co., Ltd. (private entity)	No
Switzerland	South Pole Carbon Asset Management Ltd. (private entity)	No

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

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

A.4.1.1. Host Party(ies):

Thailand

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

Kalasin Province

A.4.1.3. City/Town/Community etc:

Yangthalat

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

The address of the project is:
45 Rimmaenumparn, Theenanon Road,
Yangthalat, Kalasin 46120

The exact coordinates of the project are as follows:

16°23'7.71"N / 103°28'21.28"E

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

Type and category:

According to Appendix B to the *Simplified Modalities and Procedures for Small-Scale CDM Project Activities*, the Project type and category are defined as follows:

Methane avoidance component:

Type III:	Other project activities
Category III.H:	Methane Recovery in Wastewater Treatment
Sectoral Scope 13:	Waste handling and disposal

Electricity generation component:

Type I:	Renewable energy projects
Category I.D:	Grid connected renewable electricity generation
Sectoral Scope 1:	Energy industries (renewable /non-renewable sources)

ADDITIONAL REQUIREMENTS FOR THE GOLD STANDARD:
Project activities eligible under the Gold Standard

Please refer to Annex 5 for Gold Standard information.

Process and technology description

The technology to be implemented by the Project activity is an Upflow Anaerobic Sludge Blanket (UASB) system. Developed in the late 1970's, it is an internationally recognized "high rate" anaerobic treatment technology known for its effectiveness in the treatment of high strength organic wastewater from such operations as food processing and distilleries. The UASB system is built, owned and operated by the Thai engineering company, Papop Co., Ltd. Since it has started its business in 1997, it has accumulated know- how and experiences in construction of biogas production and utilization system.

In the UASB process, wastewater flows upward through a sludge blanket composed of microorganisms that naturally form granules or particles of 0.5 to 2 mm in diameter ("sludge granules"). When wastewater comes in contact with the granules, anaerobic decomposition of the organic material contained in the wastewater takes place, resulting in the generation of methane-rich biogas. The hydraulic turbulence caused by produced biogas bubbles provides mixing in the digester. The high sedimentation velocity of biological granules formed in the digester prevents washout of the sludge granules, leading to longer sludge retention time in the digester.

Through the utilization of this advanced technology, the Project will be able to achieve approximately 90% removal of COD, significantly reducing the COD load to the open lagoons, which subsequently receive effluent from the UASB digester.

The biogas will be used as fuel in a number of power generators (gensets) consisting of a biogas fired engine and an alternator, to generate maximum about 2,850 kWe electricity.

To combust the excess biogas, a closed flare system is installed. Flaring starts automatically whenever biogas is diverted to the flare equipment, which contains automatic ignition system and other safety devices to ensure that the biogas is always combusted

Due to the Project activity, no additional sludge will be generated. Sludge generated during the wastewater treatment process will be treated by land application.

ADDITIONAL REQUIREMENTS FOR THE GOLD STANDARD:

Gold Standard projects must result in technology transfer and/or knowledge innovation. Please refer to Annex 5 for Gold Standard information.

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

Years	Estimation of annual emission reductions in tonnes of CO_2e
Year 1	41,701
Year 2	41,701
Year 3	41,701
Year 4	41,701
Year 5	41,701
Year 6	41,701
Year 7	41,701
Total emission reductions (tonnes of CO_2e)	**291,908**
Total number of crediting years	**7**
Annual average of the estimated reductions over the crediting period	**41,701**

Table 1: Estimated amount of emissions reductions

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

No public funding is involved in the project.

ADDITIONAL REQUIREMENTS FOR THE GOLD STANDARD:
ODA Additionality Screen:

Please refer to Annex 5 for Gold Standard information.

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

The project participants confirm that there is no registered small-scale CDM project activity or an application to register another small-scale CDM project activity with the same project participants and whose project boundary is within 1 km of the project boundary of the proposed small-scale activity at the closest point.

According to Appendix C to the *Simplified Modalities and Procedures for Small-scale CDM Project Activities*, the Project is not a debundled component of a large-scale project activity.

SECTION B. Application of a baseline and monitoring methodology

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

Methane avoidance component:

The approved CDM small-scale baseline and monitoring methodology AMS III.H "Methane Recovery in Wastewater Treatment" (Version 09) is applied to the methane avoidance component of the project activity.

Electricity generation component:

The approved CDM small-scale baseline and monitoring methodology AMS-I.D "Grid connected renewable electricity generation" (Version 13) is applied to the electricity generation component of the project activity.

For more information on both methodologies, please refer to the link:
http://cdm.unfccc.int/methodologies/SSCmethodologies/approved.html

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

General small-scale projects requirements:

Recovery of methane from biogenic organic matter in wastewater:

The wastewater would have been treated in an open anaerobic lagoon in the absence of the Project. The project activity refers thus to case (vi) described in Paragraph 1 of AMS.III.H and fulfils the applicability conditions of the respective project category:

"Introduction of a sequential stage of wastewater treatment with methane recovery and combustion, with or without sludge treatment, to an existing wastewater treatment system without methane recovery (e.g. introduction of treatment in an anaerobic reactor with methane recovery as a sequential treatment step for the wastewater that is presently being treated in an anaerobic lagoon without methane recovery)"

Furthermore, the project also falls under paragraph 2(a) ; the recovered methane is utilized for thermal or electrical energy generation directly applications instead of combustion/flaring.

- The estimated emission reductions of the project activity shall not exceed 60kt CO_2e in any year of the crediting period.

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Electricity generation component:

The project activity also conforms to small-scale CDM project category AMS I.D since:

- The Project comprises the use of energy derived from renewable biomass (biogas) to supply electricity that displaces electricity from the national grid.
- The electricity generation capacity of the Project is less than 15 MW_{el}

B.3. Description of the project boundary:

The project boundary is defined as the physical, geographical site where the wastewater and sludge treatment takes place and the site where the renewable energy generation is located.

Following emission sources and gases are considered in the emission reduction calculations.

	Source	Gas	Justification / Explanation
Baseline	Lagoon	CH_4	Emission from decay of organic matter
	Electricity grid	CO_2	CO_2 emissions from fossil fuel based electricity generation plants connected to the electricity grid
Project activity	Anaerobic reactor and sludge disposal	CH_4	Emission from decay of organic matter Emission from electricity and or thermal energy consumption at the wastewater treatment plant
	Electricity consumption	CO_2	Use of electricity to run equipments used in anaerobic treatment

The system boundaries of the project activity can be illustrated as follows:

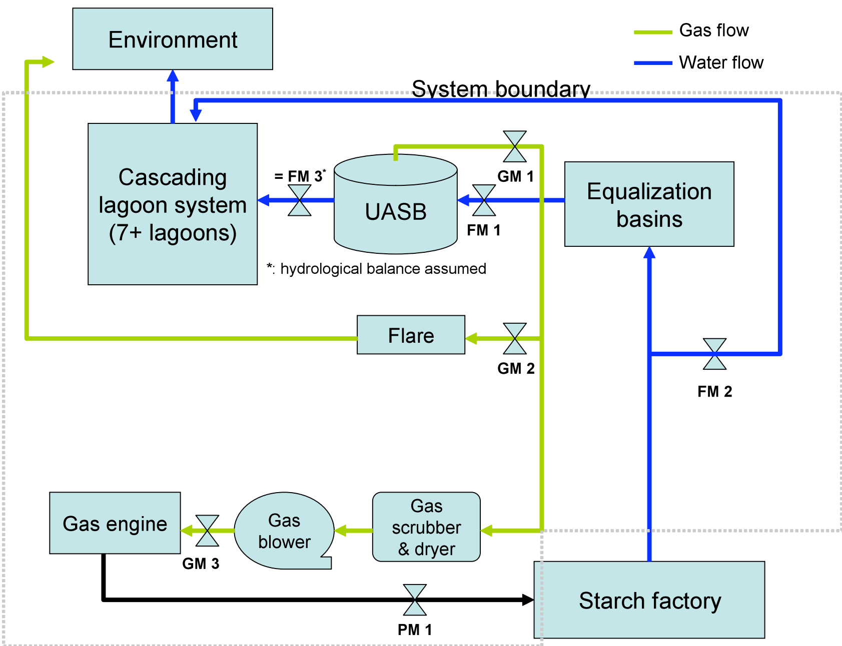

Figure 1: System Boundary

B.4. Description of baseline and its development:

Determination of the baseline scenario

At the project location, the baseline scenario is a wastewater treatment system as open anaerobic lagoons without methane recovery and electricity use from the national grid.

The new biogas reactor system is being introduced as a sequential stage with methane recovery to the existing lagoon system (as defined under applicability conditions for project activity measures under Paragraph 1 (vi) of the applied methodology, see Section B.2 above).

Therefore, according to Paragraph 23 of AMS.III.H, the baseline scenario to the project activity is defined as follows:

1. The existing anaerobic wastewater treatment system without methane recovery for the case of introduction of a sequential anaerobic wastewater treatment system with methane recovery

According to Paragraph 7 of AMS I.D, the baseline scenario is defined according to a type III category that is in this case AMS.III.H. In the baseline scenario according to AMS.III.H, there is no on-site electricity generation. Therefore, the produced electricity by the project activity displaces electricity from the national grid.

Determination of the baseline emissions

Please see B.6 for detailed justification of the key assumptions and rationale of the baseline emissions.

The major parameters and assumptions for calculation of baseline emissions are provided in the table below:.

Methodology: AMS III H (Methane avoidance part)	
$BE_{y,ww} = Q_{y,ww} \cdot \sum_j (COD_{y,removed,j} \cdot B_{o,ww} \cdot MCF_{ww,treatment,j} \cdot GWP\_CH_4)$	
$BE_{y,ww}$: Baseline emissions in year y for waste water treatment(tCO_2 e)	Calculated
$Q_{y,ww}$: Quantity of waste water treated anaerobic process in baseline (Based on the previous starch production and waste water generation data)	Monitored for ex post estimations
$COD_{y,removed,j}$: COD removed by the anaerobic wastewater treatment system (Lagoon system had a removal efficiency of more than 97%, but the baseline emissions are for the removal which is prevented by the project activity i.e. about 90% removal of COD intake[1].)	90% of inlet value
$B_{o,ww}$: Methane producing capacity of the wastewater. (IPCC default value, corrected as per methodology AMS III-H page – 4, is used for estimation)	0.21kg CH_4/kg COD
$MCF_{ww,treatment,i}$: Methane correction factor for the existing anaerobic wastewater treatment systems (Based on IPCC default value, Volume 5 Chapter 6, page 6.21. The lower value is	0.8

[1] The COD in and COD out for the waste water treatment system installed before the lagoon. In this case baseline emissions are estimated only for the 90%COD removal. Based on design specifications from manufacturer

used for conservative estimation of baseline emissions)	
GWP_CH4: Global warming potential of methane gas	21
Methodology: AMS I D	
$BE_{y,el} = EF_y \cdot EG_y$	
BE $_{y,el}$: Baseline emissions from power generation in year y	Calculated
EG $_y$: Electricity generated during year y by power generation facility	Monitored for ex post estimation
EF $_y$: Emission Factor of replaced power (Tool to calculate emission factor of an electricity system)	Calculated – Fixed ex-ante

Detailed explanation and calculation to obtain EF $_y$ is provided in Annex 3.

B.5. Description of how the anthropogenic emissions of GHG by sources are reduced below those that would have occurred in the absence of the registered small-scale CDM project activity:

The project activity conforms to the small scale baseline methodologies of AMS IIIH and AMS ID. The project reduces emission reductions by capturing the fugitive emissions from the waste water and using the biogas to generate heat and power for the industrial facility. The thermal capacity and power generation capacity of facility shall not exceed 45 MW_{th} and 15 MW_{el} respectively.

- The total installed capacity for Gas engine is 2.85 MW which is quite lower than 15MW limit for small scale methodologies. With a design efficiency of approx. 41%[2] the thermal capacity of the gas engines (combined) be approx. $7MW_{th}$; thereby making it applicable under small scale limit for CDM projects.

According to Attachment A of Appendix B of the *Simplified Modalities and Procedures for Small-Scale CDM Project Activities*, additionality of the project shall be demonstrated by providing an explanation to show that the project activity would not have occurred anyway due to at least one barrier.

The carbon credit incomes were well taken into account before the project initiation. The following table gives an overview of the timeline of the key milestones in the project implementation so far.

Out of the different possibilities to prove additionality the investment analysis is the most solid and is used for this project activity:

Date	Event	Comment
October 2005	Bangna Tapioca Flour Co. Ltd. was presented a proposal to develop the biogas project as BOOT project ("Build, Own, Operate and Transfer"). The proposal included a pre feasibility assessment including an analysis of the impact of CDM on the financial viability of the project. .	Project Feasibility Study and BOOT proposal from P&Papop Co. Ltd
1 November 2005	1st Board Meeting of Bangna Tapioca Flour Co. Ltd. to discuss the biogas project. CDM benefits are considered	Minutes of Board Meeting

[2] As per the specifications by gas engine supplier

	to be of crucial importance for reducing the financial risks attributed to the project. The Board decides to work with the company P&Papop Co. Ltd. on the implementation of the project, including application for CDM, on a BOOT basis	
20 December 2005	2nd Board Meeting of Bangna Tapioca Flour Co. Ltd. to discuss the biogas project and take decision on the same. The CDM benefits are part of discussion and a decision is made to award the BOOT contract to the company P&Papop Co. Ltd., including CDM application.	Minutes of Meeting
January 2006	BOOT Contract for electricity production from biogas between P&Papop Renewable Co. Ltd. and Bangna Tapioca Flour Co. Ltd.. The BOOT contract states that Bagna Starch Co Ltd. gives all rights over CERs to P&Papop Co. Ltd (clause 10 of the BOOT Contract). It also determines that P&Papop Co. Ltd. is responsible to handle the procedure to obtain CERs from the project activity during the validity period of the BOOT contract.	BOOT Contract
12 May 2006	Confidentiality agreement between P&Papop Co. Ltd and CER buyer determining the first formal step of CER sale/purchase negotiations.	Confidentiality Agreement
20 July 2006	First payment related to construction of the project, which is used for definition of the CDM project start date.	Purchase order
7 December 2006	Loan approval from SCB Bank	Loan approval
16 January 2007	Term Sheet between CER buyer and Papop governing the transaction of CERs of two projects, including the Bangna Starch project.	CDM term sheet outlining purchase terms of CERs
10 May 2007	Appointment of authorization from P&Papop Co. Ltd to South Pole Carbon Asset Management Ltd. for carrying out CDM related interactions with final buyers, DNA and UNFCCC.	Appointment of Authorization
22 June 2007	South Pole Carbon Asset Management contracted Advanced Energy Plus Co. Ltd. to manage the stakeholder consultation meeting and IEE report for four projects, including the Bangna Starch project.	Service contract
2 July 2007	Bangna Tapioca Flour Co. Ltd. receives the operating license for power production	Operating license page 1
25 July 2007	Initial CDM stakeholder consultation organised by Advanced Energy Plus Co. Ltd. is conducted.	Cooperation between P&Pop Renewable and Advance Energy Plus company
17 September 2007	Request for Validation contract from South Pole Carbon Asset Management Ltd. to DOE	Copy for proposal
28 September 2007	Bangna Tapioca Flour Co. Ltd. transferred P&Papop Company for operating 2.85 MW power plant	Operating license page 7
30 September 2007	Conclusion of Initial Environmental Evaluation	

10 October 2007	Submission of Letter of Approval (LoA) request to Thai DNA (Host)	Submission letter
11 October 2007	ERPA signing date between buyer and P & Papop.	ERPA Copy
21 December 2007	Commissioning of biogas generator	Commissioning test report
16 July 2008	Receive the Letter of Approval (LoA) from Thai DNA	Copy of LoA from DNA
27 September 2008	Project uploaded for UNFCCC validation	UNFCCC website

Investment analysis:

At the project location, the existing lagoons are sufficient to meet wastewater treatment needs of the facility and comply with national environmental regulations. No additional capacity expansion is planned and there is no incentive to change to a more costly technology nor does the facility need to comply with stricter discharge limits. As compared to the project activity, the existing anaerobic lagoon system requires no additional investment and their operation and maintenance costs are much lower than for the anaerobic reactor system. Nevertheless options have been searched for a profitable investment in the wastewater treatment process aiming in the avoidance of methane.

Besides the implementation of the CDM project activity it would also be possible to implement the project without CDM revenue. To prove that the project is only feasible with CDM revenues a benchmark analysis is used followed by a sensitivity analysis.

The economic key indicators of the project activity (IRR, NPV) are based on information available at the date of investment decision on 1 November 2005. The basic financial parameters of the project are listed in Table 1 below.

Table 1: The Basic Financial Parameter of the project

Installed capacity (MW)	2.85
Annual Power supplied to the Grid (MWh/yr) - maximum	10,552
Total Investment (million THB) - excluding VAT	116.3
VAT	7%
Price of electricity sold (THB/kWh)	2.8
Increase in price of power (THB/KWh/yr)	6%
Inflation rate	5.90%
CDM revenues shared with developer	16.00%
BOOT (years)	12.00
Operating costs (million THB/year)	8.16

As the BOOT[3] agreement is agreed upon 12 years the investment analysis will be bounded to the duration of the BOOT contract. The wastewater treatment system with its electricity generator will be transferred to the effluent producer at the end of the contract. The project should generate a positive profitability for the operator within those 12 years.

The economic indicator most suitable for the project type and decision context is the IRR. As per EB meeting 41 Annex 45 local commercial lending rates are appropriate as a benchmark. The MLR (minimum lending rate) of commercial banks registered in Thailand at investment decision was 6.5633%[4]. In addition the NPV is calculated to get a comparative idea of the potential income through the project during the course of BOOT project.

Loan Rates of Commercial Banks as of 1 November 2005

Bank	MOR	MLR	MRR	Ceiling*	Default*	Credit Card
Commercial Banks registered in Thailand						
Bangkok Bank	6.5000	6.2500	6.7500	10.2500	14.5000	18.0000
Krung Thai Bank	6.5000	6.2500	6.7500	14.5000	14.5000	-
Kasikornbank	6.5000	6.2500	6.7500	17.7500	21.7500	17.7500-18.0000
The Siam Commercial Bank	6.5000	6.2500	6.7500	10.2500	15.0000	18.0000
Bank of Ayudhya	6.7500	6.5000	6.7500	19.7500	27.0000	-
TMB Bank	6.7500	6.5000	6.7500	10.2500	14.5000	17.5000-18.0000
The Siam City Bank	6.7500	6.5000	6.7500	18.0000	21.0000	17.2500
Bank of Asia	7.0000	6.5000	7.2500	10.2500	18.0000	18.0000
Bank Thai	6.7500	6.5000	7.0000	24.0000	28.0000	-
Standard Chartered Bank (Thai)	7.0000	6.7000	7.7000	21.5000	29.0000	18.0000
UOB Radanasin Bank	7.0000	6.5000	7.2500	18.0000	18.0000	18.0000
Thanachart Bank	6.7500	6.5000	7.2500	14.5000	18.0000	-
TISCO Bank	7.0000	6.5000	7.2500	28.0000	28.0000	-
The International Commercial Bank of China	8.5000	8.0000	8.5000	12.0000	15.0000	-
Kiatnakin Bank	7.0000	6.7500	7.2500	28.0000	28.0000	-
Average of Commercial Banks registered in Thailand	**6.8833**	**6.5633**	**7.1133**	**17.1333**	**20.6833**	**17.9063**

To go into a BOOT contract without CDM revenues over the years would be financially not attractive for P&Papop. Both, IRR and NPV are negative and therefore would not allow investing in this project. Through the additional income through CDM the project reaches at the time of transferring the engine to the starch factory owner positive financial indicators (see Table 2).

Table 2: Comparative financial indicators with and without CDM revenues

Develop project activity with electricity revenues	IRR (%)	5.24%
	NPV (million THB)	-8.48
Develop project activity with electricity and CDM revenues	IRR (%)	17.37%
	NPV (million THB)	90.01

The figure show that developing the project without CDM revenue will end up with significant lower financial indicators then usually demanded for this project type in Thailand. Invest in a project with negative IRR and NPV is not feasible.

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[3] BOOT = Build Own Operate Transfer

[4] http://www.bot.or.th/English/Statistics/FinancialMarkets/Interestrate/_layouts/application/interest_rate/IN_Rate.aspx

Sensitivity analysis:

The project IRR could significantly vary when certain parameters are varied. Savings due to power sale, operation costs affected by inflation and the total investment are increased and decreased by 5% and 10%.

Table 3: IRR sensitivity analysis

Variation	Revenue from Power sales (IRR %)	Operation costs (IRR %)	Total Investment (IRR %)
-10%	5.15%	6.46%	6.97%
-5%	5.20%	5.86%	6.08%
0%	5.24%	5.24%	5.24%
5%	5.29%	4.61%	4.47%
10%	5.34%	3.96%	3.75%

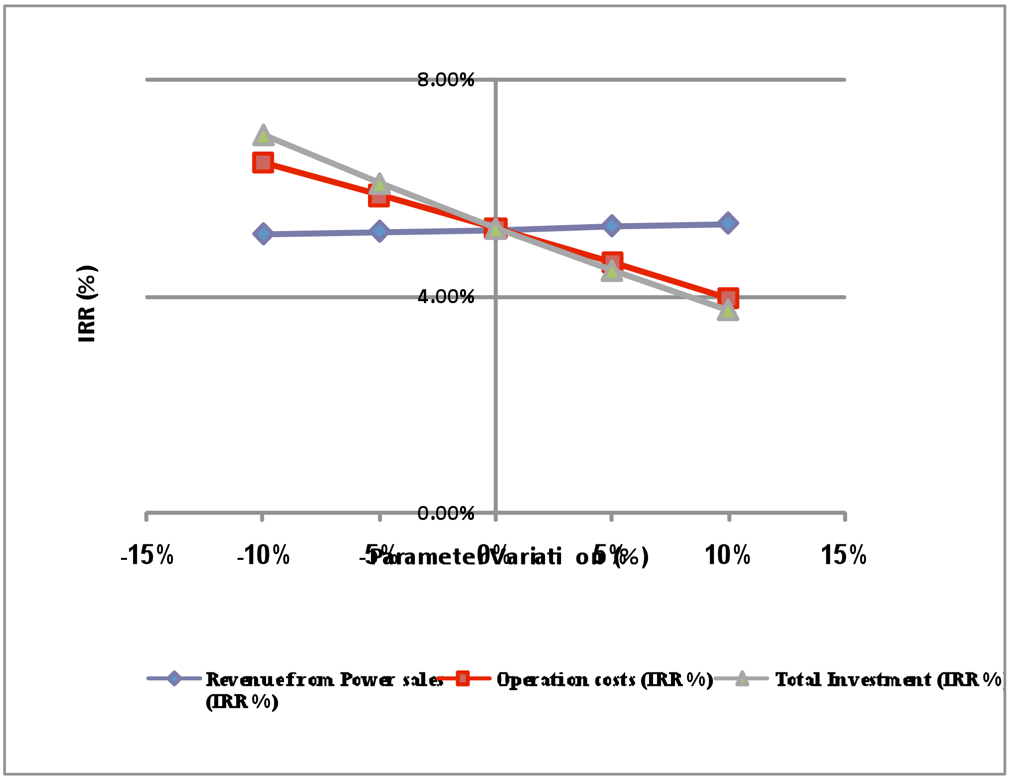

Figure 2: IRR sensitivity analysis

A similar picture occurs when analyzing the variation of the IRR. The IRR remains below the benchmark in all the cases except for the case when investment cost decreases by 10%. The reduction of investment cost by 10% would have been an unrealistic scenario.

The project cost assumptions made by the project developer were based on their vast experience in implementing similar projects. There are several precursors to prove that the 10% decrease in project cost is not only non feasible but unrealistic.

- The rate of inflation in 2005 and 2006 for housing and furnishing is higher than 1% (depends on the cost of construction material etc.) and overall inflation above 4%[5].
- The approximate cost incurred by similar project implementation in another starch industry (same process and approximate equal starch manufacturing capacity)

  a. CWTE project (2110) – registered – incurred an approximate cost of 120 million Baht as can be justified by the following links available on internet
  PDD: Cassava Waste To Energy Project, Kalasin, Thailand (CWTE project)
  Press Release: http://www.toyota-tsusho.com/data/current/detailobj-397-datafile.pdf

  b. Siam Starch (1993) – registered – incurred a project cost of 1.2 million USD + 2 million USD i.e. approx. 115 million Baht; to implement a project with a biogas system and power generation.
  PDD: Siam Quality Starch Wastewater Treatment and Energy Generation Project in Chaiyaphum, Thailand
  Reference Document:
  http://cdm.unfccc.int/UserManagement/FileStorage/URDQU5P7W4XEXW0YB1YQTMUIS96VQI

- The actual cost of the project, as per invoices would be higher than the initially assumed cost of the project[6]. As an example the cost of gas engine incurred in reality is approximately 1% higher than cost assumed in the feasibility study. The cost of construction work is approximately 4% higher in reality than the assumed value in feasibility study. This trend clearly proves that reduction in cost of project by 10% is an unrealistic scenario.

The project activity entails high investment and O&M costs and uncertain commercial returns (from the production and use of biogas). The only rationale for the investment in a costly UASB technology is the availability of additional incentives from carbon credits and revenues from electricity sales. CDM revenues play a key role in overcoming investment barriers to the project, making it financially more attractive and less risky for potential investors. CDM revenues have been considered since the beginning of the project and were a major driver for the project owner, P & Papop Renewable Co. Ltd, a technology provider of biogas reactor systems, to implement this project on a BOOT[7] basis. CDM revenues allows the project owner to have an attractive return on investment and a lower exposure to risks, such as variations of the effluent quality and quantity resulting in unexpected dying of the micro organisms and changes in electricity tariff.

Conclusion:
It is clear that the carbon credits revenues play a significant role in the financial viability of the project and that the project owner would not have invested in such a project on a BOOT basis without the consideration of carbon credits revenues. In absence of the project activity, the existing lagoons would lead to higher green house emissions due to methane release from the lagoon to the atmosphere and CO2 emissions related to fossil fuel fired power plants connected to the grid. Hence, according to Attachment

[5] http://www.indexpr.moc.go.th/price_present/cpi/data/index_47.asp?list_month=11&list_year=2549&list_region=country
http://www.indexpr.moc.go.th/price_present/cpi/data/index_47.asp?list_month=11&list_year=2548&list_region=country

[6] Copies for major costs provided say construction contract, gas engine invoice, important equipments.

[7] BOOT = Build Own Operate Transfer

A of Appendix B of the *Simplified Modalities and Procedures for Small-Scale CDM Project Activities*, Paragraph 1 (a), a financially more viable alternative to the project activity would have led to higher emissions, which confirms the existence of the investment barrier.

ADDITIONAL REQUIREMENTS FOR THE GOLD STANDARD:
Gold Standard Additionality Screen

In addition to the UNFCCC Additionality Tool, the Gold Standard Additionality Screen includes an Previous Announcement Check and ODA Additionality.

Please refer to Annex 5 for Gold Standard information.

B.6. Emission reductions:

B.6.1. Explanation of methodological choices:

The amount of methane that would be emitted to the atmosphere in the absence of the project activity is estimated according to AMS III.H, Version 9.

The baseline for this project activity corresponds to Paragraph 1, option (vi), of the methodology, defining the baseline scenario as an anaerobic wastewater treatment system without methane recovery and combustion.

The amount of CO2 that would have been emitted to the atmosphere from grid connected fossil fuel based power plants in the absence of the project activity is estimated according to methodology AMS I.D, Version 13.

Project emissions

The project activity emissions are calculated as follows:

$$PE_{y,ww} = PE_{y,power} + PE_{y,ww,treated} + PE_{y,s,final} + PE_{y,fugitive} + PE_{y,dissolved} + PE_{y,upgrading} + PE_{y,leakage,pipeline} \quad (1)$$

Where:

PE_y	Project activity emissions in the year "y" (tCO_2e)
$PE_{y,power}$	Emissions from electricity or fossil fuel consumption in the year "y"
$PE_{y,ww,treated}$	Emissions from degradable organic carbon in treated wastewater in year "y"
$PE_{y,s,final}$	Emissions from anaerobic decay of the final sludge produced in the year "y".
$PE_{y,fugitive}$	Emissions from methane release in capture and utilization/combustion/flare systems in year "y"
$PE_{y,dissolved}$	Emissions from dissolved methane in treated wastewater in year "y".
$PE_{y,upgrading}$	Emissions related to the upgrading and compression of biogas in year "y"

$PE_{y,\text{leakage,pipeline}}$	Emissions due to physical leakage from the dedicated piped network in year "y".

Project activity emissions from degradable organic carbon in the treated wastewater ($PE_{y,ww,treated}$)

$$PE_{y,ww,treated} = Q_{y,ww} \cdot COD_{y,ww,treated} \cdot B_{o,ww} \cdot MCF_{ww,final} \cdot GWP_{CH4} \quad (2)$$

Where:

$PE_{y,ww,treated}$	Emissions from degradable organic carbon in treated wastewater in year "y" (tCO_2e)
$Q_{y,ww}$	Volume of wastewater treated in the year "y" (m^3/yr)
$COD_{y,ww,treated}$	Chemical oxygen demand of the treated wastewater in the year "y" (tonnes/m^3)
$B_{o,ww}$	Methane producing capacity of the wastewater (IPCC default value of 0.21 kg CH4/kg COD)[8]
$MCF_{ww,final}$	Methane correction factor based on type of treatment and discharge pathway of the wastewater (as per AMS.III.H a value of 0.2 shall be used for wastewater discharge to sea, river or lake)
GWP_{CH4}	Global Warming Potential for methane (value of 21 is used)

Project activity emissions from anaerobic decay of the final sludge ($PE_{y,s,final}$)

$$PE_{y,s,final} = S_{y,final} * DOC_{y,s,final} * \frac{16}{12} * MCF_{s,final} * DOC_F * F * GWP_{CH4} \quad (3)$$

Where:

$PE_{y,s,final}$	Methane emissions from the anaerobic decay of the final sludge generated in the wastewater system in the year "y" (tCO_2e)
$S_{y,final}$	Amount of final sludge generated by the wastewater treatment in the year "y" (tonnes)
$DOC_{y,s,final}$	Degradable organic content of the final sludge generated by the wastewater treatment in the year "y" (fraction). IPCC default value of 0.09 for industrial sludge (wet basis, assuming dry matter content of 35 percent) will be used.
$MCF_{s,final}$	Methane correction factor of the landfill that receives the final sludge, estimated as described in category AMS III.G. A default conservative value of 1 will be used.
DOC_F	Fraction of DOC dissimilated to biogas (IPCC default value of 0.5)
F	Fraction of CH_4 in landfill gas (IPCC default of 0.5)
GWP_{CH4}	Global Warming Potential for methane (value of 21 is used)

The UASB reactor is supposed not to produce any sludge to be disposed in landfills under anaerobic conditions, whatever sludge disposal will be monitored throughout the crediting period of the Project. In this hypothesis, the most conservative parameters will be chosen : $MCF_{s,final} = 1$ and $DOC_{y,s,final} = 0.09$

[8] As per AMS.III.H, the IPCC default value of 0.25 kg CH4/kg COD was corrected to take into account the uncertainties.

Fugitive emissions from methane release in capture and flare systems ($PE_{y,fugitive}$)

$$PE_{y,fugitive} = PE_{y,fugitive,ww} + PE_{y,fugitive,s} \qquad (4)$$

Where:

$PE_{y,fugitive,ww}$ Fugitive emissions through capture and utilization/combustion/flare inefficiencies in the anaerobic wastewater treatment in year “y” (tCO2e);

$PE_{y,fugitive,s}$ Fugitive emissions through capture and ulitization/combustion/flare inefficiencies in the anaerobic sludge treatment in the year “y” (tCO2e)

The second term of the equation above is not applicable because the project activity does not comprise an anaerobic treatment system for sludge; it consists of an anaerobic treatment system for wastewater only. Hence, the term $PE_{y,fugitive,s}$ is neglected.

The first term of the equation above is calculated as follows:

$$PE_{y,fugitive,ww} = (1 - CFE_{ww}) \cdot MEP_{y,ww,treatment} \cdot GWP_{CH4} \qquad (5)$$

Where:

CFE_{ww} Capture and flare efficiency of the methane recovery and combustion equipment in the wastewater treatment (a default value of 0.9 is used).

GWP_{CH4} Global Warming Potential for methane (value of 21 is used)

$MEP_{y,ww,treatment}$ Methane emission potential of the wastewater treatment plant in the year “y” (tonnes), which is calculated according to the equation below:

$$MEP_{y,ww,treatment} = Q_{y,ww} \cdot B_{o,ww} \cdot \sum_{j} COD_{y,removed,j} \cdot MCF_{ww,j} \qquad (6)$$

Where:

$Q_{y,ww}$ Volume of wastewater treated in the year “y” (m^3/yr)

$COD_{y,removed,j}$ The chemical oxygen demand removed by the treatment system “j” of the project activity equipped with methane recovery in the year “y” (tonnes/m^3)

$MCF_{ww,j}$ Methane correction factor for the wastewater treatment system “j” equipped with methane recovery and combustion/flare/utilization equipment (MCF higher values in table III.H.1)

$B_{o,ww}$ Methane producing capacity of the wastewater (IPCC default value for domestic wastewater of 0.21 kg CH4/kg COD)[9]

For this project we will only consider one treatment system j :

- The treatment system will be the UASB digester. $COD_{y,removed,1}$ will be estimated as the difference of the COD values between the inlet and outlet of the digester.

[9] As per AMS.III.H, the IPCC default value of 0.25 kg CH4/kg COD was corrected to take into account the uncertainties.

Emissions from dissolved methane in treated wastewater (*$PE_{y,dissolved}$*)

$$PE_{y,dissolved} = Q_{y,ww} \cdot [CH_4]_{y,ww,treated} \cdot GWP_{CH4} \quad (7)$$

Where:

$PE_{y,dissolved}$	Emissions from dissolved methane in treated wastewater in year "y" (t CO_2e).
$Q_{y,ww}$	Volume of wastewater treated in the year "y" (m^3/yr)
$[CH4]_{y,ww,treated}$	Dissolved methane content in the treated wastewater (tonnes/m3). In aerobic wastewater treatment default value is zero, in anaerobic treatment it can be measured, or a default value of 10e-4 tonnes/m3 can be used
GWP_{CH4}	Global Warming Potential for methane (value of 21 is used)

Here a the default value for the dissolved methane in anaerobic treatment has been applied: $[CH4]_{y,ww,treated} = 10^{-4}$ tonnes/m^3

Emission from upgrading and use of bottled biogas *$PE_{y,\ upgrading}$* and from pipeline leakage *$PE_{y,\ leakage,\ pipeline}$*

No production, upgrading, pipeline transportation and use of bottled biogas is planned in this project, thus:

$PE_{y,\ leakage,\ pipeline} = 0$

$PE_{y,\ upgradining} = 0$

Project activity emissions from electricity or fossil fuel consumption (*$PE_{y,power}$*)

All the equipments that are involved in operation of biogas generation and consumption are to be included in estimation of power consumption. The annual power consumption (MWh) will be multiplied with the national grid emission factor of electricity (t $CO2_2$/MWh).

$$PE_{y,power} = EF_y * EC_y \quad (8)$$

Where :

$PE_{y,Power}$	Emissions from electricity or fossil fuel consumption in the year "y" (t CO_2e)
EC_y	Electricity consumed during year y from the national grid (MWh)
$EF_{grid,y}$	Emission factor from the national grid electricity consumed by the project activity during year "y" (t CO_2e/MWh)

No fossil fuel will be used for the operation of the project activity. Only electricity will contribute to $PE_{y,Power}$.. $EF_{grid,y}$ is calculated ex-amte and remains fixed during the whole crediting period. Details of calculation for grid emission factor is provided in Annex 3.

<u>Baseline emissions</u>

Baseline emissions are the sum of emissions from the degradable organic matter in the treated wastewater (calculated according to AMS.III.H version 9) and the emission due to the displacement of electricity from the grid (calculated according to AMS.I.D version 13).

$$BE_y = BE_{y,el} + BE_{y,ww} \qquad (9)$$

Where :

BE_y	Baseline emissions in the year "y" (t CO_2e).
$BE_{y,el}$	Baseline emissions from grid's electricity displaced by the project activity during the year y in tCO_2e.
$BE_{y,ww}$	Baseline Emissions from degradable organic carbon in treated wastewater in year "y".

$$BE_{y,el} = EF_y \cdot EG_y \qquad (10)$$

Where :

$BE_{el,y}$	the baseline emissions from grid's electricity displaced by the project activity during the year y in tCO_2e/MWh.
EG_y	Electricity generated during year y by power generation facility (MWh)
EF_y	Emission factor from the electricity displaced by the project activity during year "y". As electricity is exported to the grid, the emission factor of the national grid will be chosen: $EF_y = EF_{grid,y}$. (Calculated – Fixed ex-ante)

For the case of introduction of a sequential anaerobic wastewater treatment system with methane recovery (option (vi) according to AMS.III.H), Paragraph 24 of AMS III.H. Version 09, applies to baseline emissions as follows:

$$BE_{y,ww} = Q_{y,ww} \cdot \sum_j (COD_{y,removed,j} \cdot B_{o,ww} \cdot MCF_{ww,treatment,j} \cdot GWP\_CH_4) \qquad (11)$$

Where:

$BE_{y,ww}$	Baseline Emissions from degradable organic carbon in treated wastewater in year "y" (tCO_2/yr).
$Q_{y,ww}$	Volume of wastewater treated in the year "y" (m^3/yr)
$COD_{y,removed,i}$	Chemical oxygen demand removed by the anaerobic wastewater treatment systems "i" in the baseline situation in the year "y" to which the sequential anaerobic treatment step is being introduced in tonnes/m^3 (COD content of in the inlet and outlet of the lagoon system has been monitored for determination of the COD removed)
$B_{o,ww}$	Methane producing capacity of the wastewater (The IPCC default value for domestic wastewater of 0.21 kg CH_4/kg COD)[10]
$MCF_{ww,treatment,j}$	Methane correction factor for the existing anaerobic wastewater treatment systems "i" to which the sequential anaerobic treatment step is being introduced (MCF lower value in Table III.H.1.)
GWP_CH_4	Global Warming Potential for methane (value of 21 is used)

[10] As per AMS.III.H, the IPCC default value of 0.25 kg CH_4/kg COD was corrected to take into account the uncertainties.

Leakage

For AMS IIIH, there is no bottling unit thereby nil leakages on account of bottling activity.

No equipment transfer takes place as an effect of project activity, all the equipments are purchased first hand and thereby no leakage considerations.

Emission reductions

In the absence of any leakage, emission reductions are the difference between the baseline emissions and the project emissions:

$$ER_y = BE_y - PE_y \qquad (12)$$

Where :

ER_y Emission reductions in the year "y" (tCO_2e).
BE_y Baseline emissions in the year "y" (tCO_2e).
PE_y Project activity emissions in the year "y" (tCO_2e).

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

All data and parameters used for the emission reductions calculations but not monitored during the crediting period are provided in the following tables.

Data / Parameter :	GWP_{CH4}
Data unit	
Description	Global warning potential
Source of data used	Intergovernmental Panel on Climate Change, Climate Change 1995: The Science of Climate Change (Cambridge, UK: Cambridge University Press, 1996)
Value applied	GWP_{CH4} 21
Justification of the choice of data or description of measurements methods and procedures actually applied	IPCC default value
Any comments :	

Data / Parameter :	$B_{o,ww}$
Data unit	kg CH_4/kg COD
Description	IPCC default value, corrected as per methodology AMS III-H page – 4, is used for estimation

Source of data used	IPCC default value
Value applied	$B_{o,ww}$ 0.21
Justification of the choice of data or description of measurements methods and procedures actually applied	IPCC default value
Any comments :	As per AMS.III.H Version 09, the IPCC default value of 0.25 kg CH4/kg COD was corrected to take into account the uncertainties.

Data / Parameter :	MCF
Data unit	Fraction
Description	Methane correction factor
Source of data used	Table III.H.1 from AMS-III.H, Version 09 methodology and "Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site (version 02)"
Value applied	$MCF_{ww,treatment,i}$ 0.8 $MCF_{ww,1}$ 1.0 $MCF_{ww,final}$ 0.2 $MCF_{s,treatment}$ 1 $MCF_{s,final}$ 1
Justification of the choice of data or description of measurements methods and procedures actually applied	All MCF values have been chosen in a conservative manner (highest values for project and lower for baseline) according to table III.H.1 from AMS-III.H, Version 09 methodology. The value of $MCF_{s,\ final}$ is the MCF maximal value according to the "table MCF" from the "Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site (version 02)"; which is conservative.
Any comments :	The original source of data can be checked for IPCC default value, Volume 5 Chapter 6, page 6.21. The lower value is used for conservative estimation of baseline emissions.

Data / Parameter :	CFE_{ww}
Data unit	Fraction
Description	Capture and flare efficiency of the methane recovery and combustion efficiency

Source of data used	Default value specified in AMS-III.H, Version 09 methodology
Value applied	CFE_{ww} 0.9
Justification of the choice of data or description of measurements methods and procedures actually applied	In absence of an appropriate value the methodology describes to use an IPCC default value of 0.9
Any comments:	

Data / Parameter :	$EF_{grid,y} = EF_y$
Data unit	tCO2/MWh
Description	CO_2 emission factor of the Thailand grid
Source of data used	http://www2.dede.go.th/dede/cdm/index.html
Value applied	0.5057
Justification of the choice of data or description of measurements methods and procedures actually applied	Data from publically available source, published by DEDE (Ministry of energy)
Any comments:	

Data / Parameter :	$[CH_4]_{y,ww,treated}$
Data unit	Tonnes/m3
Description	Dissolved methane content in the treated wastewater
Source of data used	Methodology AMS IIIH
Value applied	$[CH_4]_{y,ww,treated}$ 0.0001
Justification of the choice of data or description of measurements methods and procedures actually applied	A default value as per the methodology is used to estimate emissions on account of dissolved methane in waste water.
Any comments:	

B.6.3 Ex-ante calculation of emission reductions:

>>

Project emissions

$$PE_{y,ww} = PE_{y,power} + PE_{y,ww,treated} + PE_{y,s,final} + PE_{y,fugitive} + PE_{y,dissolved} + PE_{y,upgrading} + PE_{y,leakage,pipeline}$$

Equation (1):

Equation (1)	Year	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
PE_y	tCO_2e	7,519	7,519	7,519	7,519	7,519	7,519	7,519
$PE_{y,power}$	tCO_2e	128	128	128	128	128	128	128
$PE_{y,ww,treated}$	tCO_2e	121	121	121	121	121	121	121
$PE_{y,s,final}$	tCO_2e	0	0	0	0	0	0	0
$PE_{y,fugitive,}$	tCO_2e	5,486	5,486	5,486	5,486	5,486	5,486	5,486
$PE_{y,dissolved}$	tCO_2e	1,785	1,785	1,785	1,785	1,785	1,785	1,785
$PE_{y,upgrading}$	tCO_2e	0	0	0	0	0	0	0
$PE_{y,leakage,pipeline}$	tCO_2e	0	0	0	0	0	0	0

Equation (4):

$$PE_{y,fugitive} = PE_{y,fugitive,ww} + PE_{y,fugitive,s}$$

Equation (4)	Year	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
$PE_{y,fugitive}$	tCO_2e	5,486	5,486	5,486	5,486	5,486	5,486	5,486
$PE_{y,fugitive,ww}$	tCO_2e	5,486	5,486	5,486	5,486	5,486	5,486	5,486
$PE_{y,fugitive,s}$	tCO_2e	0	0	0	0	0	0	0

Equation (5):

$$PE_{y,fugitive,ww} = (1 - CFE_{ww}) \cdot MEP_{y,ww,treatment} \cdot GWP_{CH4}$$

Equation (5)	Year	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
$PE_{y,fugitive,ww}$	tCO_2e	5,486	5,486	5,486	5,486	5,486	5,486	5,486
CFE_{ww}	fraction	0.9	0.9	0.9	0.9	0.9	0.9	0.9
GWP_{CH4}	tCO_2e/tCH_4	21	21	21	21	21	21	21
$MEP_{y,ww,treatment}$	tCH_4	2,612	2,612	2,612	2,612	2,612	2,612	2,612

Equation (6):

$$MEP_{y,ww,treatment} = Q_{y,ww} \cdot B_{o,ww} \cdot \sum_j COD_{y,removed,j} \cdot MCF_{ww,j}$$

Equation (6)	Year	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
$MEP_{y,ww,treatment}$	tCH_4	2,612	2,612	2,612	2,612	2,612	2,612	2,612
$Q_{y,ww}$	m^3	850,000	850,000	850,000	850,000	850,000	850,000	850,000
$COD_{y,removed,1}$	tonnes COD/m^3	0.01463	0.01463	0.01463	0.01463	0.01463	0.01463	0.01463
$MCF_{ww,\ 1}$	fraction	1	1	1	1	1	1	1
$B_{o,ww}$	kg CH_4/kg COD	0.21	0.21	0.21	0.21	0.21	0.21	0.21

Equation (7):

$$PE_{y,dissolved} = Q_{y,ww} \cdot [CH_4]_{y,ww,treated} \cdot GWP_{CH4}$$

Equation (7)	Year	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
$PE_{y,dissolved}$	tCO_2e	1,785	1,785	1,785	1,785	1,785	1,785	1,785
$Q_{y,ww}$	m^3	850,000	850,000	850,000	850,000	850,000	850,000	850,000
$[CH4]_{y,ww,treated}$	tonnes CH_4/m^3	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010
GWP_{CH4}	tCO_2e/tCH_4	21	21	21	21	21	21	21

Equation (2):

$$PE_{y,ww,treated} = Q_{y,ww} \cdot COD_{y,ww,treated} \cdot B_{o,ww} \cdot MCF_{ww,final} \cdot GWP_{CH4}$$

Equation (2)	Year	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
$PE_{y,ww,treated}$	tCO_2e	121	121	121	121	121	121	121
$COD_{y,ww,treated}$	tonnes COD/m^3	0.00016	0.00016	0.00016	0.00016	0.00016	0.00016	0.00016
$MCF_{ww,final}$	fraction	0.2	0.2	0.2	0.2	0.2	0.2	0.2

Equation (8):

$$PE_{y,power} = EF_y * EC_y$$

Equation (8)	Year	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
$PE_{y,power}$	$t\ CO_2e$	128	128	128	128	128	128	128
EC_y	MWh	253	253	253	253	253	253	253
EF_y	$t\ CO_2/MWh$	0.5057	0.5057	0.5057	0.5057	0.5057	0.5057	0.5057

Baseline emissions

Equation (9):

$$BE_y = BE_{y,el} + BE_{y,ww}$$

Equation (9)	Year	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
BE_y	tCO_2e	49,221	49,221	49,221	49,221	49,221	49,221	49,221
$BE_{y,el}$	tCO_2e	5,336	5,336	5,336	5,336	5,336	5,336	5,336
$BE_{y,ww}$	tCO_2e	43,884	43,884	43,884	43,884	43,884	43,884	43,884

Equation (10);

$$BE_{y,el} = EF_y \cdot EG_y$$

Equation (10)	Year	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
$BE_{y,el}$	tCO_2e	5,336	5,336	5,336	5,336	5,336	5,336	5,336
EG_y	MWh	10,552	10,552	10,552	10,552	10,552	10,552	10,552
EF_y	tCO_2e/MWh	0.506	0.506	0.506	0.506	0.506	0.506	0.506

Equation (11):

$$BE_{y,ww} = Q_{y,ww} \cdot \sum_{j} (COD_{y,removed,j} \cdot B_{o,ww} \cdot MCF_{ww,treatment,j} \cdot GWP\_CH_4)$$

Equation (11)	Year	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
$BE_{y,ww}$	tCO_2e	43,884	43,884	43,884	43,884	43,884	43,884	43,884
$Q_{y,ww}$	m^3	850,000	850,000	850,000	850,000	850,000	850,000	850,000
$COD_{y,removed,i}$	tonnes COD/m^3	0.0146	0.0146	0.0146	0.0146	0.0146	0.0146	0.0146
$B_{o,ww}$	kg CH_4/kg COD	0.21	0.21	0.21	0.21	0.21	0.21	0.21
$MCF_{ww,treatment,j}$	fraction	0.800	0.800	0.800	0.800	0.800	0.800	0.800
GWP_{CH4}	tCO_2e/tCH_4	21.000	21.000	21.000	21.000	21.000	21.000	21.000

Emission reductions

Equation (12):

$$ER_y = BE_y - PE_y$$

	Year	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
BE_y	tCO_2e	49,221	49,221	49,221	49,221	49,221	49,221	49,221
PE_y	tCO_2e	7,519	7,519	7,519	7,519	7,519	7,519	7,519
ER_y	tCO_2e	41,701	41,701	41,701	41,701	41,701	41,701	41,701

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

Total emission reductions (tonnes CO2e)				
Year	**Emission of project activity emissions (tCO2e)**	**Estimation of baseline emissions (tCO2e)**	**Estimation of leakage (tCO2e)**	**Estimation of overall emission reductions (tCO2e)**
Year 1	7,519	49,221	0	41,701
Year 2	7,519	49,221	0	41,701
Year 3	7,519	49,221	0	41,701
Year 4	7,519	49,221	0	41,701
Year 5	7,519	49,221	0	41,701
Year 6	7,519	49,221	0	41,701
Year 7	7,519	49,221	0	41,701
Total (tonnes CO2e)	52,636	344,544	0	291,908

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

B.7.1 Data and parameters monitored:

Following data and parameters will be monitored after the implementation of the project activity. The values provided in his section are the ones used for the ER estimations provided in this PDD.

Parameter:	$Q_{y, ww}$
Unit:	m^3
Description:	Volume of wastewater treated in the year y
Source of data:	Supervisory Control And Data Acquisition system (SCADA)
Value of data:	850,000
Brief description of measurement methods and procedures to be applied:	Volumetric flow meter at the outlet of starch factory. Denoted as FM3 Data will be recorded and stored electronically on a continuous basis. SCADA system
QA/QC procedures to be applied (if any):	Periodic calibration according to the equipment's specifications and applicable industrial standards. At least once a year
Any comment:	

Parameter:	$COD_{y, removed, j}$
Unit:	$Tonnes/m^3$
Description:	The chemical oxygen demand removed by the treatment system "j"
Source of data:	Measured – Calorimetric analysis.
Value of data:	$COD_{v.removed.1}$ 0.014634 $COD_{v.removed.i}$ 0.014634
Brief description of measurement methods and procedures to be applied:	Wastewater samples will be collected at the inlet and the outlet of the anaerobic reactor. The COD content will be analyzed using a colorimetric method in the on-site laboratory of the treatment plant. The samples results will be logged manually in the plant operation report on a daily basis. Samples collected all over the day and one measurement for COD for inlet and outlet o digester is recorded in log sheet and later transferred to electronic files. Sampling will be performed at 95% confidence level.
QA/QC procedures to be applied (if any):	The calorimetric method is well documented and well accepted either by national or international standards.
Any comment:	$COD_{y,removed,1}$ will be estimated as the difference of the COD values between the inlet and outlet of the digester. $COD_{y, removed, i}$ is equal as $COD_{y, remove,l}$. The same amount of COD is removed in both systems.

Parameter:	$COD_{y, ww, treated}$
Unit:	Tonnes/m^3
Description:	Chemical oxygen demand of the wastewater prior to discharge
Source of data:	On site laboratory analysis
Value of data:	0.00016
Brief description of measurement methods and procedures to be applied:	Wastewater samples will be collected at the last open anaerobic lagoon. The COD content will be analyzed using a colorimetric method in the on-site laboratory of the treatment plant. The samples results will be logged manually in the plant operation report on a daily basis Sampling shall be performed at 95% confidence level.
QA/QC procedures to be applied (if any):	The laboratory COD testing device shall be subject to periodic calibration according to the equipment's specifications and applicable industrial standards.
Any comment:	

Parameter:	$S_{y, final}$
Unit:	Tonnes
Description:	Amount of final sludge generated by the wastewater treatment in the year "y"
Source of data:	Measured – all the sludge quantity produced during a monitoring period is measured before final disposal / treatment
Value of data:	0
Brief description of measurement methods and procedures to be applied:	The project proponent doesn't envisage the generation of any sludge, which would be required to treat an-aerobically.
QA/QC procedures to be applied (if any):	The measurement equipment shall be calibrated on regular basis.
Any comment:	The UASB reactor is not supposed to produce any sludge.

Parameter:	$\%CH_4$
Unit:	%
Description:	Methane content in biogas
Source of data:	Measured – Online system to monitor % of methane in biogas.
Value of data:	65% expected
Brief description of measurement methods and procedures to be applied:	On-line CH_4 content measurement. Data will be recorded and stored electronically on a continuous basis.
QA/QC procedures to be applied (if any):	Periodic calibration according to the equipment's specifications and applicable industrial standards.
Any comment:	

Parameter:	$Q_{biogas, total, y}$
Unit:	Nm3
Description:	Amount of biogas that is generated in year y
Source of data:	Measured – Gas Flow meter provided at the outlet of UASB. Denoted as GM1
Value of data:	Not available for ex-ante calculation
Brief description of measurement methods and procedures to be applied:	The amount of biogas generated will be continuously measured by means of a cumulative flow meter installed after UASB. Data will be recorded and stored electronically on a continuous basis.
QA/QC procedures to be applied (if any):	The flow meter shall be subject to periodic calibration according to the equipment's specifications and applicable industrial standards.
Any comment:	

Parameter:	$Q_{biogas, flare, y}$
Unit:	Nm3
Description:	Amount of biogas that is sent to the flare.
Source of data:	Measured – Gas Flow meter provided at the inlet of flare system. Denoted as GM3
Value of data:	Not available for ex-ante calculation
Brief description of measurement methods and procedures to be applied:	The amount of biogas sent to the flare will be continuously measured by means of a cumulative flow meter installed after the blowers and before the flare. Data will be recorded and stored electronically on a continuous basis.
QA/QC procedures to be applied (if any):	The flow meter shall be subject to periodic calibration according to the equipment's specifications and applicable industrial standards. Volumetric balance of biogas shall ensure any loss of biogas in piping systems and shall be accounted for in project emissions if applicable.
Any comment:	

Parameter:	$Q_{biogas, generator, y}$
Unit:	Nm3
Description:	Amount of biogas that is sent to the electricity generator.
Source of data:	Measured - Flow meters provided at the inlet of the electricity generator system. Denoted as GM2
Value of data:	Not available for ex-ante calculation
Brief description of measurement methods and procedures to be applied:	The amount of biogas sent to the generator will be continuously measured by means of a cumulative flow meter installed at the inlet of the generator. Data will be recorded and stored electronically on a continuous basis.
QA/QC procedures to be applied (if any):	The flow meter shall be subject to periodic calibration according to the equipment's specifications and applicable industrial standards. Volumetric balance of biogas shall ensure any loss of biogas in piping systems and shall be accounted for in project emissions if applicable.
Any comment:	

Parameter:	Sufficient temperature in flare detection period

Unit:	min
Description:	Amount of minutes per hour where a flame has a higher temperature then 500°C, whenever biogas is sent to the flare. The flare efficiency is assumed to be 50% during this period of time. Whenever the flame temperature is detected to be lower then 500°C If flame temperature is detected for less than 20 minutes in an hour (whenever biogas is sent to flare), flare efficiency is assumed to be 0%. Otherwise flare efficiency is assumed to be 50%.
Source of data:	Supervisory Control And Data Acquisition system (SCADA)
Value of data:	100% (for ex-ante calculations of flare emissions it is assumed that the flare operates normally whenever biogas is sent to the flare.)
Brief description of measurement methods and procedures to be applied:	The flame detection period shall be compared to the period of biogas being sent to the flare. The flare efficiency is determined based on the ratio of these two values in analogy to the default value determination method described above.
QA/QC procedures to be applied (if any):	The temperature meter shall be subject to periodic calibration according to the equipment's specifications and applicable industrial standards.
Any comment:	

Parameter:	EC_y
Unit:	MWh/y
Description:	Electricity consumed by waste water treatment facility over the year.
Source of data:	Measured – Electricity meter at electricity drawing point for operation of the wastewater plant
Value of data:	This value is based on the full rate capacity when all the equipment installed in the project activity is operating during time the plant is in operation. 253 MW
Brief description of measurement methods and procedures to be applied:	Measured electronically on a continuous basis. Data will be recorded manually on a daily basis in the plant operation report.
QA/QC procedures to be applied (if any):	The electricity meter shall be subject to periodic calibration according to the equipment's specifications and applicable industrial standards.
Any comment:	

Parameter:	EG_y
Unit:	MWh/y
Description:	Electricity generated during year y by power generation facility
Source of data:	Measured – Electricity meter at electricity transmission point to entire wastewater treatment plant. Denoted as PM4
Value of data:	This value is based on the estimated biogas production and the generator efficiency given by the technology supplier 10551 MWh
Brief description of measurement methods and	Measured electronically on a continuous basis. Data will be recorded manually on a daily basis in the plant operation report.

procedures to be applied:	
QA/QC procedures to be applied (if any):	The electricity meter shall be subject to periodic calibration according to the equipment's specifications and applicable industrial standards.
Any comment:	

Parameter:	Period of biogas being sent to the flare
Unit:	min
Description:	Amount of minutes per hour where biogas is sent to the flare.
Source of data:	Measured/calculated based on SCADA records of biogas flow meter at the entrance of the flare.
Value of data:	- (for ex-ante calculations it is assumed that the biogas is used 100% in the boiler and engine)
Brief description of measurement methods and procedures to be applied:	Whenever biogas flow is registered by the SCADA system of the biogas plant, the time will be also recorded, which allows for a calculation of the time period of biogas being sent to the flare.
QA/QC procedures to be applied (if any):	
Any comment:	

ADDITIONAL REQUIREMENTS FOR THE GOLD STANDARD:
Data to be collected in order to monitor the project's performance on the sustainable development indicators:

The actual project performance must be assessed against the projected outcomes of the sustainable development assessment as defined in Section 3.4 of the Gold Standard Project Developer's Manual, on an annual basis.

Please refer to Annex 5 for Gold Standard information.

B.7.2 Description of the monitoring plan:

- The Parameters mentioned in B.7. 1 are a part of regular monitoring requirement of BOT operator. Most of the meters are attached to central control system, which regularly captures and stores the values of various parameters.
- The meters are calibrated at least annually against the standard equipment available with the operator and the standard meters are calibrated every two years from a certified laboratory.
- The data log from captured by control system (SCADA) can be compared against the meter readings. Meter readings are taken manually as well to maintain a backup and double check of monitored data.
- Data not captured automatically is stored manually on log books and transferred to electronic format.

Details of monitoring parameter for each one of parameter is detailed out in Annex – 4.

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

Completion date: 31/01/2008

by
Patrick Bürgi
South Pole Carbon Asset Management Ltd.
Technoparkstrasse 1
CH-8005 Zurich
Switzerland

SECTION C. Duration of the project activity / crediting period

C.1 Duration of the project activity:

C.1.1. Starting date of the project activity:

20/7/2006[11]

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

20 years

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

C.2.1. Renewable crediting period

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

01/08/2009; not before the date of CDM registration

C.2.1.2. Length of the first crediting period:

7 years

[11] Purchase order date.

C.2.2. Fixed crediting period:

C.2.2.1. Starting date:

Not applicable.

C.2.2.2. Length:

Not applicable.

SECTION D. Environmental impacts

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

The project is not considered to create significant environmental impacts. On the contrary, the project activity will result in more efficient wastewater treatment, avoiding contamination of local water streams and contributing to water conservation. The project will also alleviate odour emissions from existing lagoons.

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

The proposed project is not required to undertake an Environmental Impact Assessment according to the Thailand regulations (http://www.onep.go.th/eia/). No negative environmental effects are expected from the implementation of the project.

ADDITIONAL REQUIREMENTS FOR THE GOLD STANDARD:
EIA Requirements

The Gold Standard prescribes an elaborate process in order to determine whether an Environmental Impact Assessment (EIA) needs to be undertaken.

Please refer to Annex 5 for Gold Standard information.

SECTION E. Stakeholders' comments

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

ADDITIONAL REQUIREMENTS FOR THE GOLD STANDARD:
Public Consultation Process

In addition to the CDM stakeholder consultation requirements, the Gold Standard Public Consultation Process requires at least two public consultations and gives additional minimum requirements for the consultation process.

Please refer to Annex 5 for Gold Standard information.
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A public consultation event (based on Gold Standard stakeholder consultation criteria) was held on July 25, 2007 at Rimpao Hotel, Kalasin Province near by the project activity. The event, organized by Advance Energy Plus Co., Ltd. (AEP) and P&Papop Renewable Co., Ltd. (P&Papop) had the following aims:

1. To explain the stakeholders about Green House Gas effect, Kyoto protocol and the CDM process.
2. To present the project to the local stakeholders.
3. To describe what the CDM means for this project.
4. To describe the environmental impacts from this project.
5. To allow the stakeholders an opportunity to express their concerns regarding the project, to ask questions and to clarify issues if any.

Event location and date:

Benjaporn room, Rimpao Hotel, Kalasin Province, Thailand
July 25, 2007

In the public consultation meeting, detailed information about the project and its benefits were presented by the project advisor and the project owner to the participants who attended the meeting. The event provided a forum for all stakeholders to raise questions about pollution, safety and any other issues regarding the project and to share opinions. The tapioca-based starch production plant and brief of existing wastewater treatment, was represented by the factory. Advance Energy Plus Co., Ltd. represented the CDM project advisor.

In its introductory presentation, AEP explained the Green House Gas effect, Kyoto protocol, project in detail, and illustrated the UASB technology through several photographs and figures. The advantages and key features of the technology over existing methods of wastewater treatment were highlighted. The impact of the new technology to the community and global environment at large were also discussed.

Invited stakeholders

AEP and P&Papop invited a number of stakeholders to attend the Public Consultation event, including representatives of the government, local officials, NGOs, academic institutions, members from the local community living in the project area and others. Major institutions represented are listed below:

- **Thai Government Entities**
  - National Science and Technology Development Agency (NSTDA)
  - Office of Natural Resources and Environmental Policy and Planning
  - IIEC (International Institute for Energy Conservation)
  - Leader of Subdistric Administrative Organization Thambol Aummao
  - Subdistric Administrative Organization Thambol Aummao
  - Public Health Officer of Ban Aummao
  - Provincial Energy Officer
  - Leader of Aummao Withayakhom School
  - Provincial Industrial Officer
  - Provincial Environmental Officer
  - Leader of Thambol Aummao
  - Leader of Ban Aummao
  - Leader of Ban Huakhua

- **NGOs**
  - Green Leaf Foundation
  - Green World Foundation (GWF)
  - IIEC (International Institute for Energy Conservation)
  - WWF Thailand
  - Thailand Development Research Institute (TDRI)
  - Appropriate Technology Association
  - Environmental Engineering Association of Thailand
  - Thai Environmental and Community Development
  - Thailand Environment Institute (TEI)

- **Academia**
  - Faculty of Engineering, Khon Kaen University
  - Faculty of Engineering, Chulalongkorn University
  - Faculty of Engineering, King Mongkut's University of Technology Thonburi
  - Faculty of Engineering, Suranaree University of Technology
  - Faculty of Engineering, Thammasat University
  - Faculty of Engineering, Kasetsart University
  - Faculty of Engineering, Dhurakijpundit University
  - Faculty of Environment and Resource Studies, Mahidol University

E.2. Summary of the comments received:

Q & A session was announced at the event, where questions were invited from the related parties. The questions were basically answered by the AEP, P&Papop and Bangna Tapioca Flour Co,.Ltd. Questions and answers are listed in the following sections:

- *What is the aim of this project? Does the company aim to invest in biogas system in all of starch plants?*

This project aim to produce biogas from wastewater. Not only starch plant can invest in biogas system, but also the other sectors such as pig farm. We would like to implement such systems in other starch plants as well, but it depends always on the size of the project and its financial.

- *The wastewater effluent from the system has some mineral that can use as the fertilizer. Is it possible to allow the villager use this wastewater as the fertilizer?*

Yes, we can release the wastewater effluent from the system to the villager, but if you would like to use it as fertilizer, please ask the provincial agricultural officer for the usage portion.

- *Can you give priority to the villagers of Ban Moo 10 to work in the plant?*

Yes, we can. It is the policy of the company to give priority to qualified villagers who live around the plant for employment.

- *After a certain period of usage, is there a possibility of gas tank explosion?*

The construction of the gas tank is very robust. Digester tank is made of cement concrete which is much stronger and better than the earth pond. The thickness of the tank is 50 cm, which can withstand a pressure of 9.5 metres of water and the cover can withstand a gas pressure and has release system on the top of tank. With this construction, the chances for explosion are almost nil.

Biogas has an auto-ignition temperature of more than 400°C, and requires an air-gas mixture of 90-95%. These conditions are not present in the digester tank at any time, and therefore the tank is safe from explosions.

- *How many ton of cassava which consume by the starch plant?*

The starch plant consume fresh cassava approximately to 700 ton per day. This year we have insufficient fresh cassava in this area, therefore the starch plant has to buy from other areas also.

Before end of the seminar, Provincial Environmental Officer, Mr. Jumnong Dechwithi said that this project will give benefits to people around the plant in terms of energy and environmental. It is the good sign for Kalasin province.

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

Given the positive and encouraging character of the comments received during the stakeholder consultation process, there was no need to change or adapt the project activity.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

Organization:	P & Papop Renewable Co., Ltd. Hat Yai Song Khla, 90110 Thailand
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Last Name:	
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Represented by:	
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Annex 2

INFORMATION REGARDING PUBLIC FUNDING

No public funding is involved in the project

Annex 3

BASELINE INFORMATION

Official document from DEDE website made available.

Annex 4

MONITORING INFORMATION

Monitoring Parameter	Monitoring method / equipment	Risk related to data management	Sensitivity of data for Emission Reduction calculation	Rationale for data reliability
$Q_{y,ww}$	Flow Meters – 2 in line	Low	Important for both ex-ante and ex-post approach	There are two flow meters one at outlet of starch factory and another one before entry into equalization pond. The meter at outlet of starch factory is attached to SCADA system and the other meter in line provides a cross check of the readings.
$COD_{y, removed, j}$	Exhaustive sample collection	Medium	Only ex-ante calculation	The exhaustive sampling shall ensure that fluctuations due to process during a day are normalized and reliable COD measurements are available for both inlet and outlet.
$COD_{y, ww, treated}$	Exhaustive sample collection	Medium	Only ex-ante calculation	The exhaustive sampling shall ensure that fluctuations due to process during a day are normalized and reliable COD measurements are available for both inlet and outlet.
$S_{y, final}$	Log records and transportation details	Low	For ex-post estimation	The sludge removed shall be estimated for the weight transferred and records of end use shall be maintained.
$\%CH_4$	Online Methane analyzer	Low	For ex-post estimation	The methane analyzer is connected to SCADA system and records the methane percentage in produced biogas and the records can be used to estimate exact amount of methane generated in the process. In case of meter malfunctions the data range available for remaining time period shall be used to determine a conservative value of methane percentage to estimate emission reductions.
$Q_{biogas, total, y}$	Gas flow meter	Low	For ex-post estimation	The Gas flow meters shall ensure the volumetric balance of

Q $_{biogas, flare, y}$	Gas flow meter	Low	For ex-post estimation	biogas between source and usage points. The same shall take care of any possible leakages in system and be accounted for in project emissions if required. Based on experience and continuous monitoring it shall be easy to identify any potential meter malfunctions and correct the same. For purpose of emission reduction estimation proper conservative factors be taken into account in case of meter malfunctions.
Q $_{biogas, generator, y}$	Gas flow meter	Low	For ex-post estimation	
Flare Temperature	Temperature gauge connected to control system	Medium	For ex-post estimation	The temperature gauge records the temperature of flare burning to ensure methane destruction. For any malfunction in the data recording, conservative estimation of emission reductions shall be carried out.
EC $_y$	Electricity Meter	Low	For ex-post estimation	The power supplied by regional grid is metered by electricity meters and the invoice is available as issued by provincial electricity authority.
EG $_y$	Electricity Meters	Low	For ex-post estimation	The power generated by each generator is available individually as well a combined meter is installed after the three generators on outgoing line to monitor th total power supplied. Out of this power used internally is also available separately from another meter. The meter readings shall enable to estimate the net power generated by biogas system. However the monthly invoice from Provincial electricity authority shall be used for purpose of emission reduction estimations. This is to ensure conservativeness,
Time of biogas sent to flare	Biogas flow meter	Low	For ex-post estimations	The parameter cna be accurately monitored and compared against the temperature readings which are also recorded continuously. This shall ensure the proper flaring of methane when the biogas is being supplied to flare.

For CER Estimations – Ex-post and ex-ante

To ensure conservativeness of emission reduction estimation the emission reduction shall be estimated using both ex post and ex-ante approach and use the conservative of the two approaches to estimate emission reductions in ex-post scenario.

The two approaches depend on different monitored parameters; thereby also ensuring back up calculation possibility to check the conservativeness of emission reductions.

Annex 5

GOLD STANDARD INFORMATION

See separate document.

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