



**Project Description
(VCS 2007.1 standard)**

**SD Biosupply Wastewater Treatment and
Biogas Utilization Project**

Date of the VCS PD: November 19th, 2009 (PDD Version 6.4)

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1 Description of Project:

1.1 Project title

SD Biosupply Wastewater Treatment and Biogas Utilization Project

VCS PD Version: 6.4

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1.2 Type/Category of the project

The project activity involves recovery of fugitive methane emissions using a UASB system and utilizing the biogas thus produces as a fuel, thereby replacing the fossil fuel earlier used by the project participants.

The project has a thermal generation capacity less than 45 MW_{th} and will generate emission reductions less than 60 ktCO₂e per year. The type/category of the project is thus according to Appendix B, *Simplified Modalities and Procedures for Small-Scale CDM Project Activities*, 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
Version	12

Thermal energy generation component:

Type I:	Renewable energy projects
Category I.C:	Thermal energy for the user with or without electricity
Sectoral Scope 1:	Energy Industries
Version	14

The project is not a grouped project.

1.3 Estimated amount of emission reductions over the crediting period including project size:

Expected VERs per annum:	18,432	tCO ₂ e/year
VERs expected over 10 years crediting period:	184,324	tCO ₂ e

The project is neither micro- nor mega-project, with the estimated emission reductions being in the range of 5,000-1,000,000 tCO₂e/year.

The project proponent has chosen a 10-years crediting period (renewable) for the project activity.

After the initial crediting period of ten years, subsequent renewals of the crediting time might be considered according to the status of the project activity and baseline revision at that time.

1.4 A brief description of the project:

The proposed project was implemented at SD Starch Co. Ltd. in 18th August 2005¹. The starch plant has a total production capacity of 300 tonnes of native starch per day, generating wastewater up to 2000 m³ for every production day². Prior to implementation of the project activity, the wastewater of the starch plant the plant was treated in 8 cascading open anaerobic lagoons, with a retention time of more than a year. The minimum depth of these ponds is more than 2.0 m from the water surface. The average atmospheric temperature in the region is 28 degree celsius³. These conditions result in anaerobic environment within the ponds, resulting in methane generation from the organic content (characterized by chemical oxygen demand or COD) of the wastewater.

The proposed project activity entails the installation of an anaerobic wastewater treatment facility, based on Upflow Anaerobic Sludge Blanket (UASB) biogas reactor technology, at the existing starch manufacturing plant, replacing the open anaerobic lagoon based system. The biogas reactor system will generate and recover biogas for energy generation purposes, avoiding methane emissions to the atmosphere. The captured methane will be used as fuel in existing heat generating devices in the starch plant replacing heavy fuel oil partially, which will lead to further green house gas emission reductions (CO₂) by replacing a fossil fuel. Any surplus methane is flared in an open flare. The boiler in this case already exists at the project site as an integral part of starch plant operation. Fuel oil is used in baseline and will be partially replaced in the project activity.

The quality of the treated water, which is subject to effluent standards regulated by the environmental authorities, will improve substantially due to higher efficiency and improved process control of the biogas reactor as compared to open lagoons. In fact, the biogas reactor system allows the starch factory to reuse the treated effluent in the cassava production process, contributing to water conservation. Further, the project will avoid odour emissions as compared to an anaerobic lagoon, which contributes significantly to an improved life quality around the project site.

The project activity does also contribute to technology transfer from Thailand and efficiency improvement of the agro-industry, which will benefit a rural and underdeveloped region of the country. New jobs are created during the construction and operation of the biogas reactor system and regional economic development is fostered through contracts to local firms related to construction, operation and maintenance of the plant.

1.5 Project location including geographic and physical information allowing the unique identification and delineation of the specific extent of the project:

The project site is located on the site of the SD Starch factory, located at address: 99 Somdej-Khuchinarai, Kambong, Huai Phueng District, Kalasin, about 580 km away from Bangkok. The project coordinates are 16°40'40.20"N and 103°48'19.67"E

¹ Based on the commissioning report

² 3000 m³ in proposal is design value of treatment system. At lower COD loadings the wastewater generation from starch plant can go high but the estimations are based on historical records.

³ Data requested from the Thai Meteorological Department

1.6 Duration of the project activity/crediting period:

Project start date: 16th September 2005 (the date when emission reductions began⁴).

As per VCS 2007 guidelines, the start date of crediting period start date is defined as 28th March 2006

The duration of the project activity is estimated to last 15 years⁵. After the initial crediting period of ten years, subsequent renewals of the crediting time might be considered according to the status of the project activity and baseline revision at that time.

1.7 Conditions prior to project initiation:

Prior to project initiation, the wastewater from the tapioca processing plant was treated in a cascade of 8 open anaerobic lagoons⁶. The anaerobic lagoons are still in use at the project activity being used as secondary treatment after the UASB biogas reactor (at least 95% COD removal takes place in the reactor and the remaining concentration is removed in the lagoons).

1.8 A description of how the project will achieve GHG emission reductions and/or removal enhancements:

In the absence of the project, the wastewater from the tapioca processing plant would have been treated in open anaerobic lagoons. After the implementation of the UASB reactor, methane generated is recovered and used as an alternative to fossil fuel. This achieves emission reduction in two ways:

- Avoidance of fugitive methane emissions to the environment by using UASB digesters.
- Avoidance of carbon dioxide emissions from replacement of fossil fuel with biogas.

1.9 Project technologies, products, services and the expected level of activity:

UASB technology is used in the project for biogas generation from wastewater with a high concentration of organic content by anaerobic digestion. This is a two-stage technology, involving an Acidification System and a UASB reactor. The organic matter in the wastewater is represented by its Chemical Oxygen Demand (COD) values.

In the first stage, starch in wastewater is converted into Volatile Fatty Acids through the Acidification System that uses Acedogenic Bacteria. The pH of wastewater drops significantly due to the acidification process. In the second stage, effluent from the Acidification System is processed through the UASB reactor after neutralizing it with lime. The UASB reactor can briefly be described as a system in which wastewater passes first through an expanded sludge bed containing a high concentration of biomass. The sludge in the reactor may exist in granular or flocculent form. Most of the organic matter removal takes place in the sludge bed. The remaining portion of the substrate passes through a less dense biomass, called the sludge blanket. Above the sludge blanket, the reactor has a three-phase

⁴ The first date of biogas production and utilization in boiler

⁵ The confirmation letter of expected lifetime of UASB reactor is 15 years

⁶ The description here is based on design document of the baseline wastewater treatment system. For reference, they all have depth of greater than 2 m (2 m to 3.5 m) thus can all be regarded as anaerobic lagoons.

Gas-Liquid-Solid (GLS) separator, which separates the solid particles from the liquid and gas, allowing liquid and gas to leave the system. The system is diagrammatically represented in the figure under Section 2.3.

The organic matter in the wastewater is digested by Methanogenic Bacteria in the UASB reactor. This results in the production of biogas, consists of methane and carbon dioxide, which are separated in GLS separator and collected for further use as a fuel or flared.

Biogas usage in boiler is enabled as a part of the project activity for heat generation purpose. The boiler is a dual fuel fired boiler and the fuel oil is replaced partially in project activity. The thermal energy delivered by the boiler is monitored as a part of project activity and the fossil fuel in the project activity is also monitored to determine the project emissions.

1.10 Compliance with relevant local laws and regulations related to the project:

The proposed project activity is in compliance with all local laws and regulations from the local government section and the Ministry of Industry⁷, Thailand as follows.

Laws and regulations	Control on	Demonstration of the compliance
Regulation on the limitation of discharge wastewater	Limit on COD of 120 mg/l of wastewater from starch factory that can be discharged out of the factory.	This project did not discharge wastewater to outside of the factory, instead the wastewater is used in the plantation area and cleaning process of root cassava as raw material

Moreover, the project activity needs to get acceptance from the local stakeholders since any negative comments from stakeholders can affect the operation permit approval from the Department of Industrial Works (DIW). A valid operational permit shall ensure that all the regulations prescribed by local and national authorities are met and complied to.

1.11 Identification of risks that may substantially affect the project's GHG emission reductions or removal enhancements:

Major risks that may substantially affect the project's GHG emission reductions are related to the performance of the biogas reactor system. Given the fact, that biogas reactors rely on a biological process, the system is sensitive to variations in the effluent quality and quantity. An appropriate reactor design and experienced plant operators play a major role in the performance success of such systems. Malfunction of the biogas reactor might lead to less biogas production (replacing less fossil fuel) and a higher COD concentration of the wastewater leaving the reactor, which would lead to higher project emissions. Leakage of biogas or malfunction of the flare system might also lead to higher project emissions, reducing the emission reduction potential of the project. All these issues are addressed in the emission reduction calculation and monitoring procedures addressed in the VCS PD.

⁷ Notification by the Ministry of Industry, No. 2, B.E. 2539 (1996) issued under the Factory Act B.E. 2535 (1992); Re: Standard of Discharging Effluent from Factories. The maximum permissible COD content of wastewater discharge is 400 mg/l for all types of industry. Note that there is a special provision for starch plants stipulating that 5-day BOD is not to exceed 60 mg/l and COD is not to exceed 120 mg/L.

1.12 Demonstration to confirm that the project was not implemented to create GHG emissions primarily for the purpose of its subsequent removal or destruction.

The lagoons described in this VCS PD as the baseline scenario were in use for several years before the project implementation. The fuel oil fired in boiler has also been in used for many years prior to the implementation of this project activity. This demonstrates that GHG emissions from the previous system would anyway have been emitted to the atmosphere and thus acts as a confirmation that they were not created for the purpose of its subsequent removal or destruction. Relevant documents assessing the date of biogas reactor construction is provided to the DOE⁸.

1.13 Demonstration that the project has not created another form of environmental credit (for example renewable energy certificates).

The project is not applying to any other form of environmental credit.

1.14 Project rejected under other GHG programs (if applicable):

N.A., the project did not apply under other GHG programs.

1.15 Project proponents roles and responsibilities, including contact information of the project proponent, other project participants:

The project participants are listed in the following tables:

Role	Project owner (responsible for implementation and operation of the project activity)
Organization:	SD Biosupply Co. Ltd.
Address:	113 Soichokchaijonjamrern, Rama III Road
City:	Bangpongpan, Yannawa, Bangkok10120
Country:	Thailand
Telephone:	0-2683-1900-7
FAX:	0-2683-0892
Represented by:	Sutee Suralertrungsri
Title:	Managing Director
Salutation:	Mr.

Role	Carbon Asset Management (responsible for development of emission reductions through the Voluntary Carbon Standard)
Organization:	South Pole Carbon Asset Management Ltd.
Street/P.O.Box:	Technoparkstrasse 1
City:	Zurich
Postfix/ZIP:	8005

⁸ The biogas construction contract is signed on 6th October 2004 with the same time of the construction started by Papop company

Country:	Switzerland
E-Mail:	i.puhl@southpolecarbon.com
URL:	www.southpolecarbon.com
Represented by:	Ingo Puhl
Title:	Managing Partner
Salutation:	Mr.
Mobile:	+ 66 86 778 2869
Direct tel:	+ 66 2 678 8979

1.16 Any information relevant for the eligibility of the project and quantification of emission reductions or removal enhancements, including legislative, technical, economic, sectoral, social, environmental, geographic, site-specific and temporal information.):

The project activity contributes the sustainable development in more than one way.

Economic Dimension:

The construction, operation and maintenance of the biogas plant generate local employment. The displacement of fuel oil with biogas means less dependence on imported fossil energy, resulting in energy security and foreign exchange savings.

Environmental Dimension:

The proposed project activity captures the methane which otherwise would have been released the atmosphere, and use it for energy purpose, thereby achieving better local air quality. The risk of groundwater contamination is overcome by reducing the COD of wastewater in a concrete digester before it is released to the tail-end ponds. Also, the treated water is recycled for use in the plant, and is not released into any surface water body, thus promoting a better local environment. The implementation of the project does not divert land under agriculture or natural growth, as well as that linked to cultural heritage. Therefore, it is not expected to affect any biodiversity sensitive areas, or other ecologically or culturally important sites in the region. The sludge from the wastewater treatment system has a potential to be applied as a fertilizer for agriculture.

Social Dimension:

The involvement of local employees in the project activity will help to enhance the skills of the labor in the region by training them in different technical areas. In addition, the close collaboration between external experts and local counterparts is expected to promote long-term sustainable partnerships, benefiting the local stakeholders. The substitution of fuel oil with biogas due to the project activity will result in increased availability of these fuels in the local market. The noise, arising from pumps and blowers operating in the biogas plant, is insignificant. There are no other occupational health issues identified. The safety aspects of operating the biogas plant will be sufficiently addressed. Stainless steel piping is used for transporting the generated gas, which avoids all possibilities of corrosion, leakage and fire hazard.

Technology Dimension:

The project involves the use of some imported components and hence the transfer of technology from outside the country. The UASB technology is already available in a few local industries and hence the local technology transfer is enhanced. The use of this technology in wastewater treatment by the project owner will popularize the technology know how in the nearby areas and in the plants looking for similar technologies in the country. Also, the locally produced equipment may be put to use in other parts of Thailand for similar purposes.

Legislative:

The project meets all the statutory requirements. Evidence of permits for the implementation of the project such as operation permit, property deed, among others, is provided to the DOE for the validation process.

Geographic/site specific:

The project can be uniquely identified with no barriers regarding logistic. In addition, it is not located in sensitive area such as protected area or where there is any fragile or vulnerable habitats close by. Thus, there are no issues preventing the eligibility of the project in this regard.

Temporal information:

The project will not double count the GHG emissions during the ten years renewable of the crediting period.

1.17 List of commercially sensitive information (if applicable):

Not applicable - no commercially sensitive information has been excluded, and all information shall be shared during validation of the VCS PD.

There are no trade secrets, financial, commercial, scientific, technical or other information whose disclosure could reasonably be expected to result in a material financial loss or gain, prejudice the outcome of contractual or other negotiations or otherwise damage or enrich the person or entity to which the information relates.

2 VCS Methodology:

2.1 Title and reference of the VCS methodology applied to the project activity and explanation of methodology choices:

Baseline & Monitoring Methodology:

- AMS III.H: Methane Recovery in Wastewater Treatment, version 12, EB 47.
- AMS I.C: Thermal energy for user with or without electricity, version 14, EB 46.

AMS. III.H., refers to:

- “Tool to determine project emissions from flaring gases containing methane”, Annex 13, EB 28

AMS.I.C., refers to:

- “Tool to calculate project or leakage CO₂ emissions from fossil fuel combustion” version 1.2.
- “Tool to calculate baseline, project and/or leakage emissions from electricity consumption” version 1.0;

These methodologies and tools can be found on the UNFCCC’s website at the following address:

<http://cdm.unfccc.int/methodologies/SSCmethodologies/approved.html>

2.2 Justification of the choice of the methodology and why it is applicable to the project activity:

Applicability for AMS III.H: Methane avoidance

The project satisfies following applicability conditions of the approved small-scale CDM methodology

- the project activity recovers methane from biogenic organic matter in wastewater
- the estimated emission reductions of the project activity will not exceed 60kt CO₂e in any year of the crediting period

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 AMS III.H and fulfils the applicability conditions of the respective project category:

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

Applicability for AMS I.C: Thermal Energy

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

- The project comprises the use of energy derived from renewable biomass (biogas) to supply thermal energy (without electricity generation) that displaces fossil fuel (Heavy fuel oil).
- The thermal generation capacity of the project is less than 45 MW_{th}

2.3 Identifying GHG sources, sinks and reservoirs for the baseline scenario and for the project:

As per the AMS III.H., AMS I.C. and AMS I.D., the project boundary shall respectively include the following:

“The project boundary is the physical, geographical site where the wastewater and sludge treatment takes place in baseline and project situation. It covers all facilities affected by the project activity including sites where the processing, transportation and application or disposal of waste products as well as biogas takes place”.

“The physical, geographical site of the project equipment producing the renewable energy delineates the project boundary. The boundary also extends to the industrial, commercial or residential facility, or facilities, consuming energy generated by the system and the processes or equipment that is affected by the project activity.

	Baseline activity			
	Source	Gas	Included	Justification
	Emission from the existing wastewater treatment system, i.e., open lagoon system	CH ₄	Included	Emission from decomposition of organic matter in anaerobic conditions.
		CO ₂	Excluded	CO ₂ emissions from the decomposition of organic matter are not accounted for because biogenic in nature.
		N ₂ O	Excluded	Excluded for simplification.
	Thermal energy Generation (Boiler)	CO ₂	Included	Emission from fuel oil consumption in the baseline scenario.
		CH ₄	Excluded	Excluded for simplification. This is conservative
		N ₂ O	Excluded	Excluded for simplification. This is conservative
	Wastewater treatment system	CH ₄	Included	The treatment of wastewater under the project activity are from: – Decomposition of the organic matter in the open anaerobic lagoons - Physical leakage from the bio-digester - Incomplete flaring
		CO ₂	Excluded	CO ₂ emissions from the decomposition of organic matter are not accounted for because biogenic in nature.
		N ₂ O	Excluded	Excluded for simplification. This is conservative.
Project activity	On-site electricity use	CO ₂	Included	On-site electricity consumed by project activity (digester pumps and other electrical equipment), which is not generated from biogas will be accounted for.
		CH ₄	Excluded	Excluded for simplification. This emission source is assumed to be very small.
		N ₂ O	Excluded	Excluded for simplification. This emission source is assumed to be very small.
	On-site fossil fuel consumption	CO ₂	Included	Emission from fuel oil consumption in the project scenario.
		CH ₄	Excluded	Excluded for simplification. This is conservative
		N ₂ O	Excluded	Excluded for simplification. This is conservative

The definition of the system boundaries for calculation of project and baseline emissions is provided in the figure below.

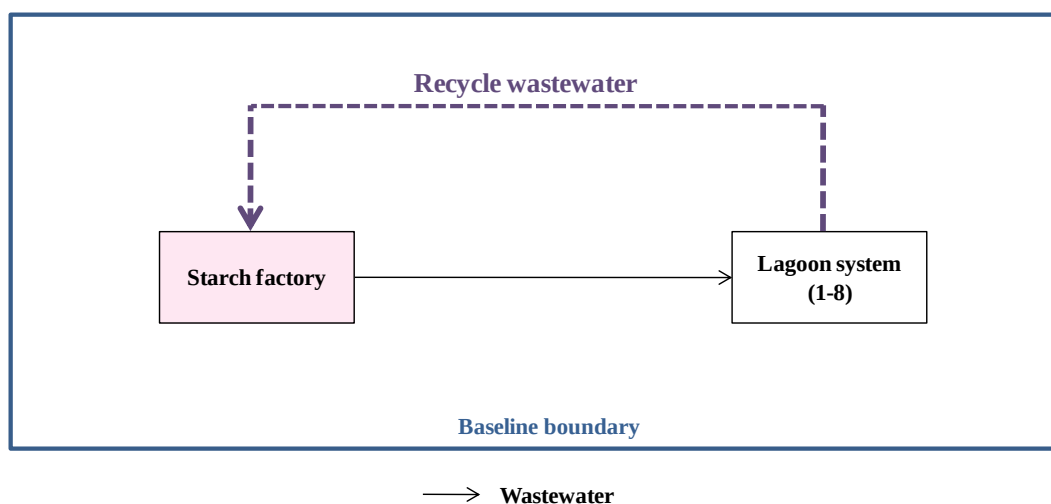


Figure 3: The baseline system boundary

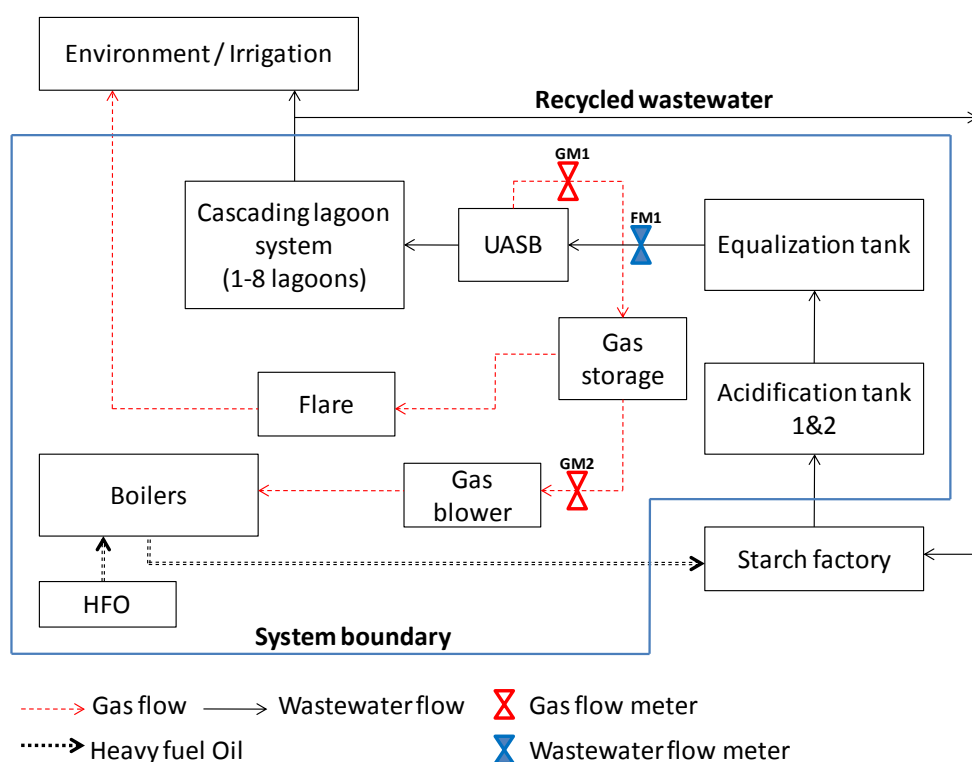


Figure 4: The project system boundary (after UASB digester implementation)

2.4 Description of how the baseline scenario is identified and description of the identified baseline scenario:

Methane avoidance component:

At the project location, open anaerobic lagoons without methane recovery represent the existing wastewater treatment system and the 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 2.2 above).

Therefore, according to Paragraph 1 of AMS III.H, the baseline scenario to the project activity is defined as follows:

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

The baseline scenario consists of 8 anaerobic lagoons⁹, which were used to treat wastewater prior to project implementation. The lagoons had an average depth of 3.0 m. The following table gives the description of lagoons at the starch facility.

Table 1: Characteristics of the baseline open anaerobic lagoons at the starch facility

No.	Area	Depth	Volume	Retention time	
	m ²		m ³	day	Month
1	12,080	3.5	42,280	30	1.0
2	14,636	3.5	51,226	37	1.2
3	15,188	3.5	53,158	38	1.3
4	20,912	3.5	73,192	52	1.7
5	21,924	3	65,772	47	1.6
6	16,184	3	48,552	35	1.2
7	26,624	2.5	66,560	48	1.6
8	48,764	2	97,528	70	2.3

According to the principle design of the anaerobic pond depth is 2.0-3.5 m¹⁰. Therefore, the open lagoons of starch factory are under anaerobic process because the retention time and depth of ponds are higher than principle design value.

Thermal energy generation component:

In absence of the project activity, the project would use fossil fuel oil in boiler to produce thermal energy. According to AMS.I.C version 14, baseline emissions are calculated as per paragraph 15 of the methodology. Please refer to section 4.1, equation 3 for further details.

During the years 2002, 2003 & 2004, the HFO consumption in starch drying process can be summarized as follows:

Year	Average HFO consumption L/kg of dry starch	HFO Consumption in litres
2002	0.0338	2,187,940
2003	0.0345	2,303,060
2004	0.0375	2,111,970

The project activity will result in a partial replacement of the HFO requirements of the starch plant. Please see Section 4.1 for the estimation of the expected fuel replacement by the project activity. The ex-ante estimation of the baseline emissions for the thermal energy component is based on the historical consumption of fuel oil per tonne of dry starch production i.e. specific fuel oil consumption is used to ex ante baseline emissions.

⁹ The open lagoon depth (cross section drawing) is provided

¹⁰ Source: Pollution Control Department, Ministry of Natural Resources and Environment, website http://www.pcd.go.th/info_serv/water_wt.html#s7

2.5 Description of how the emissions of GHG by source in baseline scenario are reduced below those that would have occurred in the absence of the project activity (assessment and demonstration of additionality):

Consideration of carbon revenues prior to the investment decision

As a first step to assess and demonstrate the additionality of the project activity, a chronological list of events is provided below in order to show how revenues from carbon credits have been considered prior to the investment decision. The table below gives an overview of key milestones in project implementation to date, demonstrating how continuing actions have been taken by the project owner and the technology provider to generate additional revenues from carbon credits in order to improve the financial feasibility of the project.

Table 2: The timeline and key events for the project

Date	Event	Comment
1 st March 1994	The starch factory starts operation	Source: Operation permit for starch factory (Somdej Flour Mill Co., Ltd.)
July 2004	The technical and commercial proposal is submitted by the technology provider	Source: Technical and commercial proposal by Papop Co., Ltd
28 th July 2004	Letter by Papop Co., Ltd. to Somdej Flour Mill Co. Ltd. outlining the importance of carbon credit revenues in order to improve the financial feasibility of the project.	Source: Letter by Papop Co., Ltd
9 th August 2004	Internal board meeting to discuss the feasibility of the biogas project, highlighting the need for carbon credit revenues as a crucial factor for the viability of the project.	Source: Minutes of board meeting of Somdej Flour Mill Co., Ltd. Somdej Flour Mill Co., Ltd. decided to pursue carbon finance through intermediation of Papop Co., Ltd.
7 th September 2004	SD Biosupply Co.Ltd. is registered as company	Source: Company affidavit
6 th October 2004	Biogas Construction contract signed (Project investment decision date)	Source: Design and construction contract between Somdej Flour Mill Co. Ltd. and Papop Co., Ltd
10 th June 2005	SD Biosupply Co., Ltd. starts operation.	Source: Operation permit permits for SD Biosupply Co., Ltd.
18 th August 2005	The first date of wastewater entered to UASB reactor referred to commissioning report.	Source: The confirmation commissioning report sent from Papop Co., Ltd.
16 th September 2005	The first date of emission reduction starts. (Project starting date)	Source: The first log sheet shows the biogas production and utilization in boiler and flare.
25 th January 2006	Project starting date (commissioning date)	First date of biogas production and utilization

12 th May 2006	Papop Co.,Ltd. signed the Confidentiality Agreement with South Pole Asset Management and Papop Co.,Ltd	Start of discussions between South Pole Asset Management and Papop Co.,Ltd. The agreement covers a portfolio of emission reduction projects, including SD Biosupply Co.Ltd.
10 th May 2007	Appointment of Authorization by Papop Co.,Ltd for South Pole Carbon Asset Management to represent Papop projects for DNA approval, validation and CDM registration, among others.	Source; Appointment of Authorization Letter between Papop Co.,Ltd and South Pole Carbon Asset Management
20 th February 2008	ERPA signed between SD Biosupply Co. Ltd. and South Pole Carbon Asset Management.	Emission Reduction Purchase Agreement signed after long negotiation period.
12 th March 2008	Signature of VCS Validation contract between South Pole Carbon Asset Management and DOE.	

The above chronology of events clearly demonstrates that the incentive from carbon credits were seriously considered in the decision making process to proceed with the project activity and that continuing actions were taken to secure such revenues for the project activity in parallel with its implementation.

It is pertinent to note that despite pioneering efforts by Thai developers, who were among the first in the world to attempt to develop CDM projects from as early as 2001, the first batch of Letters of Approval (LoAs) for CDM projects were not handed out by Thai Designated National Authority until 2007. These delays in establishing a functional CDM market were mainly related to the political situation in Thailand, caused by the political turmoil surrounding the military coup in 2006. It was only in 2008, after normalisation of the political situation, that the processes for DNA approval were consolidated and normalized. During this period, CDM project development in Thailand was subject to a high degree of uncertainty and many potential CDM projects had to look for alternatives such as the voluntary carbon markets in order to secure revenues from carbon credits. This was also the approach followed by the proposed project activity after introduction of South Pole Carbon Asset Management by the technology provider Papop Co., Ltd, who had established a strategic cooperation with South Pole in 2006.

Additionality assessment

Referring to the definition stated in the VCS Program Guidelines (section 2.2), the ‘additionality’ criteria rectify that “project-based GHG emission reductions and removals must be additional to what would have happened under a business as usual scenario if the project had not been carried out”.

In order to ensure that assessment of additionality is robust, alternative scenarios to the project activity have been identified for comparative assessment.

Possible alternatives to the project activity are as below:

1. Situation prior to project implementation: wastewater is treated in open anaerobic lagoons
2. Proposed project activity undertaken without being registered as VCS project activity
3. Aerobic waste water treatment

4. Direct discharge
5. Methane recovery and flaring

Project additionality is confirmed using the project test:

Step 1: Regulatory surplus

Alternatives 1, 2, 3 and 5 are in compliance with current law in Thailand, which allows the use of open lagoon systems and other waste treatment technologies that meet effluent standards for the discharge of treated wastewater into the environment (COD $\leq$ 120 mg/l and 5-day BOD not exceeding 20 mg/l)¹¹. There is no other regulatory requirement for the implementation of a specific wastewater treatment technology such as anaerobic digester or aerobic treatment system to tapioca starch processing plants for effluent treatment. Therefore, alternatives 1, 2, 3 and 5 do not face any legal barriers. Alternative 4 does not comply with Thai laws and regulations since it is not allowed to discharge untreated wastewater. Alternative 4 cannot be considered a plausible alternative to the project and is excluded from further analysis.

No other environmental asset or financial instrument is created by the project.

The project operator does not have a voluntary corporate emission reduction target. Project is not a downstream energy efficiency project in a jurisdiction with a mandatory GHG emissions cap.

Step 2: Implementation barriers

Thailand is one of the largest producers of tapioca starch. The starch extraction process requires a vast volume of water which in turn produces large amount of wastewater. Open lagoon treatment system i.e., the status quo system is most widely practiced method to treat starch processing wastewater^{13, 14}. This practice is low cost and usually least cost in both capital, and operation & maintenance cost^{15, 16}.

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.

The project activity entails high investment and operation and maintenance costs and uncertain commercial returns (from the production and use of biogas). VER revenues play a key role in overcoming financial barriers to the project, making it financially less

¹¹ Notification by the Ministry of Industry, No. 2, B.E. 2539 (1996) issued under the Factory Act B.E. 2535 (1992); Re: Standard of Discharging Effluent from Factories. Note that an exception has been made to starch plants that 5-day BOD is not to exceed 60 mg/l and COD not to exceed 120 mg/l. As well, the maximum permissible COD content of wastewater discharge is 400 mg/l for all types of industry.

¹³ Rajbhandari, B.K., Annachatre, A.P. 2004, Anaerobic ponds treatment of starch wastewater: case study in Thailand. *Bioresource Technology* 95 (2004) 135–143.

¹⁴ The Promotion of Biogas from Wastewater as An Alternative Energy and for Environmental Improvement, published by the Energy Conservation and Renewable Energy Division and Energy Policy and Planning Office (EPPO), 2007.

¹⁵ Cinara, 2004 “Waste stabilization ponds for wastewater treatment, International Water and Sanitation Centre” <http://www.irc.nl/page/8237>

¹⁶ Mara, D., 2003, Waste Stabilization Ponds: Time for Aggressive Marketing <http://www.bvsde.paho.org/bvsacd/agua2003/mar.pdf>

risky. GHG reduction revenues have been considered since the beginning of the project and were a major driver for implementing the project.

The statements above shall be demonstrated based on an Internal Rate of Return (IRR) analysis of the project activity without consideration of additional carbon revenues and comparison to a suitable financial benchmark in order to demonstrate that the project activity is financially not feasible without VER consideration.

Choice of Benchmark

Since the project activity is financed using a combination of loan and equity financing, the appropriate benchmark rate of return is determined as the Weighted Average Cost of Capital (WACC). Both the project IRR and the WACC figures provided below are calculated on a pre-tax basis.

The WACC is defined as the average return expected across the different types of capital that finance a given project.

The WACC will be calculated as follows

$$WACC = \frac{E}{V} * R_e + \frac{D}{V} * R_d$$

Where:

R_e : cost of equity (expected return on equity)

R_d : cost of debt

E : Amount of equity in the project

D : Amount of debt in the project

V : Total investment cost (E + D)

Determine the cost of equity

Following an approach developed by Mr. Adamoran (Professor of Finance at Stern School of Business at New York University¹⁷). The cost of equity can be established based on: (a) risk free rate, increased by (b) a suitable risk premium to reflect private investment in a certain country (taking country risk into account) and by (c) a specific premium to reflect potential project or technology risks.

- a) The approach envisages the application of US Treasury bond rate¹⁸ to simulate a “risk-free” cost of equity, which is equivalent to 4.97% at the date of the investment decision.
- b) A risk premium factor is added to the US Treasury bond rate in order to reflect the equity market risk, taking the specific country risk into account, which is equivalent 6.64% for Thailand in the period prior to the investment decision.

¹⁷ www.damodaran.com

¹⁸ http://www.ustreas.gov/offices/domestic-finance/debt-management/interest-rate/ltcompositeindex_historical.shtml

- c) For the sake of simplicity and conservativeness, no project or technology risk premium is taken into consideration for this project activity.

Therefore, the expected return of equity can be written as:

$$\text{Expected Return} = \text{Risk free Rate} + \text{Risk Premium}$$

We assume that the risk premium in any equity market is equal to:

$$\text{Risk premium} = \text{Base premium for Mature Equity Market} + \text{Country Risk Premium}$$

The country premium reflects the extra risk in a specific market.

Since the US equity market is a mature market and there is sufficient historical data in the United states to make reasonable estimate of the risk premium, we choose the US treasury bond rate as base premium for mature equity market. Historical data of the US market is used.

The simplest measure of country risk is the rating assigned to a country's debt by a rating agency, which measures default risk. These ratings come with default spreads over the US treasury bond. The default spreads only measure the premium for default risk. The country equity risk premium is, however, larger than the country default risk spread. Therefore, the volatility of the equity market in a country relative to the volatility of the country bond used to estimate the spread needs to be addressed. This yields the following estimate for the country equity risk premium:

$$\text{Country Equity Risk Premium} = \text{Country Default Spread} (\sigma_{\text{Equity}} / \sigma_{\text{Country Bond}})$$

The data set on Damodoran website provides the calculated annual value of the Country Equity Risk Premium and of the mature equity market risk for the same year.

In 2004, the Equity market risk + country risk for Thailand is equal to 6.64%.

It shall be noted that the riskfree rate chosen in computing the premium has to be consistent with the risk free rate used to compute expected returns. The US Treasury bond rate has been chosen for the calculation of the benchmark.

The sum of factors (a) and (b) provided above results in a final cost of equity value of **11.61%** (= 4.97% + 6.64%).

Since risk free rates shall be over the same maturity and default-free, the only significant factor that can cause differences between risk free rates for different countries is expected inflation. High inflation currencies have higher riskfree rates than low inflation currencies. Since the project is located in Thailand and the currency in which the cash flows are estimated is the Thai Baht, another approach would be to use the Thai government bond rate. Based on the fact that on October 6th 2004, the value for 15 year Thai government bonds was 5.50%¹⁹, this approach would result in a value of 5.51% + 6.64% = 12.15%, which is higher than the value described above.

For the sake of conservativeness, the approach based on the US Treasury bond rate is applied.

Determine the cost of debt

¹⁹ <<http://www.thaibma.or.th/yieldcurve/YieldTTM.aspx%20On%20October%206th%202004>>

The cost of debt is based on the Minimum Lending Rate in Thailand as per local bank rates on the day of investment decision. The value of 5.9125%²⁰ is obtained.

Calculation of Benchmark

	THB	%
Total Cost of the project	52,932,207	
Loan from Bank	30,000,000	57%
Equity Portion	22,932,207	43%

Cost of Debt	5.91%
Cost of Equity	11.61%

WACC	8.38%
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Calculation of Project IRR

As per EB 39 Annex 35 paragraph 3 the maximum equipment lifetime of 15 years is assumed in terms of conservativeness. However common practice in this industry is a much lower lifetime expectation.

Lifetime WWTP (years)	15	Expected lifetime
Total Investment (Euro) - WWTP	1,035,819	Technical Proposal from Technology providers and invoices
Price of fuel oil – replaced by biogas (THB/l)	8.15	Average price of HFO - EPPO
<u>Exchange Rate(THB/Euro)</u>	51.10	Based on the investment decision date
Amount of fuel oil used (tonnes)	2,068	Historical Data
Operating costs – Wastewater (Euro/year)	46,197	Technical Proposal
Man Power Cost (Euro/year)	14,677	Technical Proposal

The IRR analysis for project activity gives following result.

Develop project activity without VER revenues	IRR (%)	6.10%
Develop project activity with VER revenues	IRR (%)	10.00%

The figures show that developing the project without VER revenues will end up with lower financial indicators then usually demanded for this project type in Thailand.

²⁰ See value for 6 October 2004 in following database:
http://www.bot.or.th/English/Statistics/FinancialMarkets/Interestrates/_layouts/application/interest_rate/IN_Rate.aspx

The analysis sheet is provided and the calculations are kept simple by not considering the inflation either for yearly investments or savings on fuel oil replacement.

Sensitivity analysis

Purpose of sensitivity analysis is to show whether the conclusion regarding the financial attractiveness is robust to reasonable variations in the critical assumptions. The project IRR could vary significantly when certain parameters are changed. The parameters most likely to vary are: methane generation, operation and management costs, initial investment and the price of fuel oil. These parameters are thus increased and decreased by 10%. From this, it can be concluded that the IRR always remains below the benchmark when varying these parameters, disabling thus any investment in this project without VER revenues.

Sensitivity analysis	Change in methane generation (ton/year)	Operation and maintenance cost (EUR/year)	Investment cost (EUR)	Fuel oil price
-10%	3.77%	6.62%	7.55%	3.77%
-5%	4.96%	6.36%	6.80%	4.96%
0%	6.10%	6.10%	6.10%	6.10%
5%	7.18%	5.84%	5.45%	7.18%
10%	8.22%	5.57%	4.84%	8.22%

Step 3: Common practice

Since the proposed VER project is not a “first-of-its-kind”, a common practice analysis is conducted.

Open lagoons treatment system has been a common practice of handling wastewater from tapioca starch production in Thailand for the last thirty years. Most of the tapioca starch production facilities in the project region utilize open lagoon based systems for treating wastewater²¹. According to the Energy Conservation and Renewable Energy Division and Energy Policy and Planning Division of the Ministry of Environment, Government of Thailand “Most of the tapioca starch plants choose to retain wastewater in their open lagoons because of insufficient knowledge /confidence in the technology, high investment cost compared to cheap land price, the resulting operating cost throughout the treatment life”²².

The following analysis clearly demonstrated that the proposed project activity is not a common practice in Thailand.

Sub-step 3a. Analyze other activities similar to the proposed project activity

According to the Tool for the demonstration and assessment of additionally, projects are considered “similar” in case where they;

- are located in the “same country/region”,
- are of “similar scale”, and

²¹ Rajbhandari, B.K., Annachatre, A.P. 2004, Anaerobic ponds treatment of starch wastewater: case study in Thailand. Bioresource Technology 95 (2004) 135–143.

²² The Promotion of Biogas from Wastewater as An Alternative Energy and for Environmental Improvement, published by the Energy Conservation and Renewable Energy Division and Energy Policy and Planning Office (EPPO), 2007 Page no. 47.

- “take place in a comparable environment with respect to regulatory framework, investment climate, access to technology, access to financing, etc”.

The common practice analysis is conducted based on data that reflects the situation in Thailand around the time of investment decision for this particular project activity.

In 2007, there was an average of 6.52²³ million of rai²⁴ of cassava cultivation areas in Thailand, most of which is located in the Eastern and Northeastern regions, especially Nakorn Ratchasima, Chaiyaphum and Kalasin (where the project is located) provinces. In total, there are 85 native starch factories, mostly located in the Northeastern (46%) and in the Eastern region (33%) of the country, followed by the Central (14%) and the Northern region (7%), respectively¹. The starch factories are normally closely distributed in the cassava cultivation areas. Furthermore, cassava cultivation and starch production practices do not vary significantly throughout the country. Thus, Thailand is chosen as the common practice comparison region.

In Thailand, most of the wastewater management systems for starch production plants are open anaerobic lagoons²⁵, which require little investment, have low operation and maintenance costs and fulfil the national regulations for wastewater discharge. From 85 starch factories 25²⁶ have installed anaerobic digesters (29.4%) as of mid 2007. Given the lack of literature outlining the number of biogas plants in 2004, when the investment decision for the proposed project activity was made, the common practice analysis is based on the year 2007, which is conservative from an additionality point of view due to the growing number of biogas plants over time. Thus, based on literature from 2007, the proposed project needs to be compared with a total of 25 projects.

Sub-step 3b. Discuss any similar options that are occurring

From the 25 projects, one project has been registered by the CDM Executive Board as of mid 2007 (see Table B.1). Another 13 projects have received the letter of approval from Thai DNA, and have made details available for public comment on the UNFCCC CDM website at that time (see Table B.2). Three projects were planning to apply for CDM at that time and have all made requests to receive the letter of approval from Thai DNA recently, thus initiating the CDM application process (see Table B.3). The remaining 8 projects are currently undergoing validation and initial verification under VER standards as in Table B.4²⁷. These projects had an intention to register under CDM; however, due to delays in establishing the Thai DNA and the subsequent standstill of the DNA’s work during the political turmoil surrounding the military coup (and the interim government from 2006/2007), these projects could not apply for CDM and opted for the voluntary carbon market.

Thus, none of the 25 installed biogas reactor projects are being implemented without taking additional revenues from carbon credits into account, which reinforces the credibility of the existence of similar barriers that avoid these projects from being successfully implemented without consideration of carbon credits.

Table B. 1: The project has been registered by the CDM Executive Board

²³ Source: <http://www.thaitapiocastarch.org/article05.asp>

²⁴ A rai is a unit of area, which is equal to 1,600 square meters (40 m x 40 m), used for measuring land area. It is commonly used in Thailand.

²⁵ Source: <http://www.thaitapiocastarch.org/article01.asp>

²⁶ Source: Biogas promotion report from Ministry of Energy. <http://cdm.unfccc.int/UserManagement/FileStorage/S1XU6WGJZ7L98IFKRNBC3E0AHDT4Q2>

²⁷ Source: South Pole Carbon Asset Management’s projects. A copy of the company’s project management tool is enclosed in Attachment V.

No.	Project Title	Project Developer
1	Korat Waste to Energy (KWTE) ²⁸	Korat Waste to Energy Company Ltd.

Table B. 2: The projects available for public comments on the UNFCCC CDM website

No.	Project Title	Project Developer
1	Eiamburapa Company Ltd. Tapioca Starch wastewater biogas extraction and utilization project, Sakaeo Province, Kingdom of Thailand ²⁹	Eiamburapa Co., Ltd.
2	Siam Quality Starch Wastewater Treatment and Energy Generation Project in Chaiphaphum, Thailand ³⁰	Siam Quality Starch Co., Ltd
3	C.P.A.T tapioca processing wastewater biogas extraction and utilization project, Nakhonratchasima Province, Kingdom of Thailand ³¹	Corn Product Amardass (Thailand) Ltd.
4	Wastewater treatment with Biogas System in a Starch Plant for Energy and Environment Conservation in Nakorn Ratchasima ³²	Sima Interproduct Co., Ltd.
5	Chok Chai Starch Wastewater Treatment and Energy Generation Project in Uthai Thani, Thailand (the Project) ³³	Chok Chai Starch Co., Ltd.
6	Kalasin Wastewater Treatment to Energy ³⁴	Kalasin Waste to Energy Ltd
7	Northeastern Starch (1987) Co.,Ltd. – LPF Fuel Switching Project ³⁵	Northeastern Starch (1987) Co., Ltd.
8	Jiratpattana Biogas Energy Project ³⁶	Thai Biogas Energy Company
9	Kitroongruang Biogas Energy Project ³⁷	Thai Biogas Energy Company
10	Chao Khun Agro Biogas Energy Project ³⁸	Thai Biogas Energy Company
11	Cassava Waste To Energy Project, Kalasin, Thailand (CWTE project) ³⁹	Cassava Waste To Energy Co., Ltd.
12	Wastewater Treatment with Biogas System (AFFR) in a Starch Plant for Energy & Environment Conservation at Chachoengsao ⁴⁰	Sima Interproduct Co., Ltd.
13	CYY Biopower Wastewater treatment plant including biogas reuse for thermal oil replacement and electricity generation Project, Thailand ⁴¹	CYY Bio Power Co Ltd.

Table B. 3: The projects having requested LoA

²⁸ Source: <http://cdm.unfccc.int/Projects/DB/KPMG1175141470.89/view>

²⁹ Source: <http://cdm.unfccc.int/Projects/Validation/DB/A8JT0K03JKGLSDSV101Y0JISTYYNHN/view.html>

³⁰ Source: <http://cdm.unfccc.int/Projects/DB/SGS-UKL1217944948.76/view>

³¹ Source: <https://cdm.unfccc.int/Projects/Validation/DB/577FGXFHP9SZENI4QQNQS4I51GPWV0/view.html>

³² Source: <http://cdm.unfccc.int/Projects/Validation/DB/STKRYOPZAL8SQYQUSJDJ3SFZRFBWEI/view.html>

³³ Source: <http://cdm.unfccc.int/Projects/Validation/DB/LQTJF5681NVDBMDZ353AK88VQOJ0YS/view.html>

³⁴ Source: <http://cdm.unfccc.int/Projects/Validation/DB/D7GX65CTGLH8Y7WW6EQSD567Q6TYNJ/view.html>

³⁵ Source: <http://cdm.unfccc.int/Projects/Validation/DB/W6LK3QZGNWBK541V7XOM5ZUK7PJA63/view.html>

³⁶ Source: <http://cdm.unfccc.int/Projects/DB/DNV-CUK1218619436.44/view>

³⁷ Source: <http://cdm.unfccc.int/Projects/Validation/DB/EMVWWRZQUBBJ97FX1D3I9SA6CWJEP2/view.html>

³⁸ Source: <http://cdm.unfccc.int/Projects/DB/DNV-CUK1218616482.16/view>

³⁹ Source: <http://cdm.unfccc.int/Projects/DB/TUEV-SUED1218551520.16/view>

⁴⁰ Source: <http://cdm.unfccc.int/Projects/Validation/DB/PGE32ZZPYJSAJ4ACZ6ER89YSSI59M7/view.html>

⁴¹ Source: <http://cdm.unfccc.int/Projects/DB/RWTUV1218617500.62/view>

No.	Project Title	Project Developer
1	Wastewater Treatment with Biogas Technology in a Tapioca processing plant at Roi Et Flour Company Limited, Thailand ⁴²	Roi-Et Flour Co., Ltd.
2	Wastewater Treatment with Biogas Technology in a Tapioca processing plant at P.V.D. International Company Limited, Thailand ⁴³	P.V.D International Co., Ltd.
3	Eiamheng Tapioca Starch Industry Co., Ltd. Tapioca starch wastewater biogas exatraction and utilization project, Nakornratchasima Province, Kingdom of Thailand ⁴⁴	Eiamheng Tapioca Starch Industry Co., Ltd.

Table B. 4: The projects applying for VER⁴⁵

No.	Project Title	Project Developer
1	Wastewater Treatment with Biogas production (UASB) and heat utilization at General Starch Co Ltd	General Starch Co., Ltd.
2	Banpong Tapioca Flour Industrial Wastewater Treatment and Biogas Utilisation Project	Banpong Tapioca Flour Industrial Co., Ltd.
3	Chol Charoen Group Wastewater Treatment with Biogas System (Chonburi)	Chol Chareon Co., Ltd.
4	Chol Charoen Group Wastewater Treatment with Biogas System (Khon Kaen)	Kean Chareon Co., Ltd.
5	Chol Charoen Group Wastewater Treatment with Biogas System (Kampangpet)	Kean Chareon (II) Co., Ltd.
6	Chol Charoen Group Wastewater Treatment with Biogas System (Chacheongsoa)	S.C. Industry Co., Ltd.
7	Thanawat wastewater treatment and biogas utilization project	Thanawat Biogas Co., Ltd.
8	Chakangrao Starch wastewater treatment and biogas utilization project	Chakangrao Starch Co., Ltd.

Conclusion of the project test:

The proposed project activity is not implemented to respond to any laws or regulations. The proposed project activity also faces several barriers and cannot be considered as a common practice. The carbon credits' incentive would help to bridge the gap and making project less risky in terms of financial returns.

3 Monitoring:

3.1 Title and reference of the VCS methodology (which includes the monitoring requirements) applied to the project activity and explanation of methodology choices:

- AMS III.H “Methane Recovery in Wastewater Treatment” (Version 12)

⁴² Source: http://www.tgo.or.th/english/index.php?option=com_content&task=view&id=17&Itemid=29
The Danish Government has entered a CER purchase agreement with the project (see <http://www.danishcarbon.dk/OurProjects/cdmprojects/Thailand/RoiEtFlourCompany/>)

⁴³ Source: http://www.tgo.or.th/english/index.php?option=com_content&task=view&id=17&Itemid=29

⁴⁴ Source: http://www.tgo.or.th/english/index.php?option=com_content&task=view&id=17&Itemid=29

⁴⁵ Source: South Pole Carbon Asset Management's projects. A copy of the company's project management tool is enclosed in Attachment V.

- AMS I.C “Thermal energy for the user with or without electricity” (Version 14)

3.2 Monitoring, including estimation, modelling, measurement or calculation approaches:

Details on the monitoring approaches used in quantifying and reporting GHG emissions and/or removals relevant for the project and baseline scenario shall be elaborated in section 3.3 and 3.4. However, the overall monitoring procedures include the following criteria:

- Purpose of monitoring – to verify the emission reductions using actual data
- Types of data and information to be reported, including units of measurement – see section 3.3
- Origin of the data – see section 3.3
- Monitoring, including estimation, modelling, measurement or calculation approaches – calculation for monitoring will be made based on recorded data required by the applied methodologies available. In circumstances whereby methodology deviations are necessary, this will be clearly pointed out in section 3.3 of this VCS PD and again in the monitoring report associated with the verification process.
- Monitoring times and periods, considering the needs of intended users – vary; depend on the parameters.
- Monitoring roles and responsibilities – project proponents will be involved in collection of monitoring information.
- Quality control and quality assurance of monitoring procedures, including periodic calibration of meters and other equipments applied as per monitoring plan
- GHG information management systems – the acquired data shall be kept at the starch processing plant for a minimum of crediting year plus 2 years.

3.3 Data and parameters monitored / Selecting relevant GHG sources, sinks and reservoirs for monitoring or estimating GHG emissions and removals:

The SCADA diagram provided below gives an overview of the main monitoring devices and their position within the plant layout.

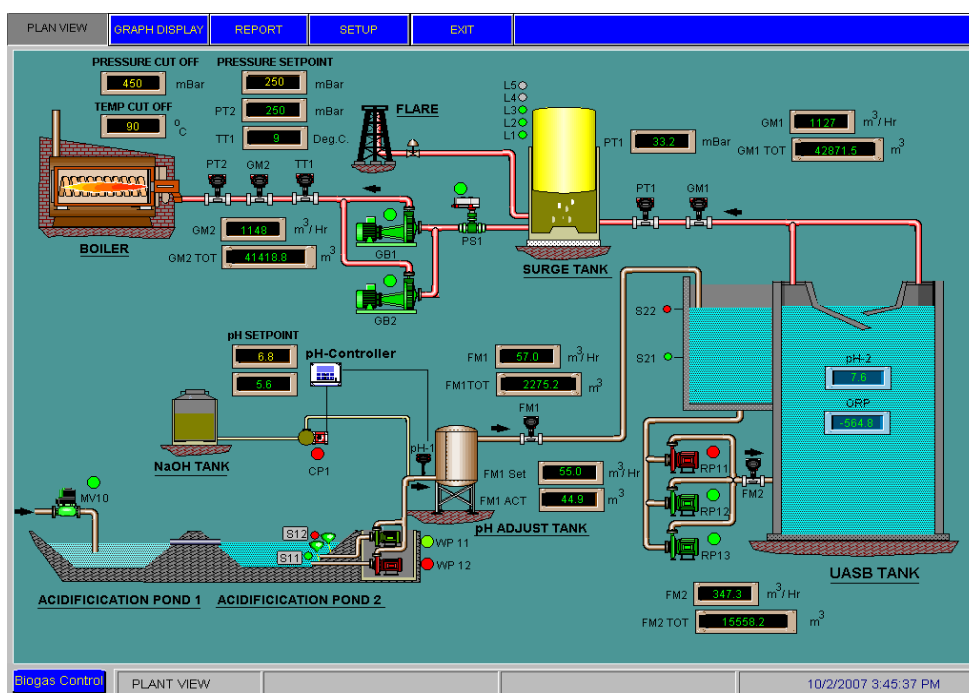


Figure 5: SCADA diagram

Please note that not all monitoring parameters described below are represented in the diagram above. The complete monitoring plan, including all parameters to be monitored and procedures to be followed are described below and compliance with the same will be subject to verification.

Parameters for which the values are fixed, throughout the crediting period:

Data / Parameter:	GWP _{CH4}
Data unit:	-
Description:	Global Warning Potential for methane
Source of data used:	Based on AMS III.H version 12, as per equation (2)
Value applied:	21
Justification of the choice of data or description of measurement methods and procedures actually applied :	Intergovernmental Panel on Climate Change, Climate Change 1995: The Science of Climate Change (Cambridge, UK: Cambridge University Press, 1996)
Any comment:	-

Data / Parameter:	B _{o, ww}
Data unit:	kg CH ₄ /kg COD
Description:	Methane producing capacity of the wastewater
Source of data used:	IPCC default value, corrected as per methodology AMS III.H is used for estimation
Value applied:	0.21 kg CH ₄ /kg COD
Justification of the choice of data or description of measurement	IPCC default value. Based on AMS III.H version 12.

methods and procedures actually applied :	
Any comment:	As per AMS III.H Version 12, the IPCC default value of 0.25 kg CH ₄ /kg COD was corrected to 0.21 kg CH ₄ /kg COD to take into account the uncertainties.

Data / Parameter:	UF_{BL}
Data unit:	Factor
Description:	Model correction factor to account for model uncertainties
Source of data used:	AMS III.H., Version 12
Value applied:	0.94
Justification of the choice of data or description of measurement methods and procedures actually applied :	According to the AMS III.H Version 12, correction factor will be used for estimation of baseline emissions.
Any comment:	-

Data / Parameter:	UF_{PJ}
Data unit:	Factor
Description:	Model correction factor to account for model uncertainties
Source of data used:	AMS III.H Version 12
Value applied:	1.06
Justification of the choice of data or description of measurement methods and procedures actually applied :	According to the AMS III.H, Correction factor will be used for estimation of project activity emissions.
Any comment:	

Data / Parameter:	MCF_{ww, treatment, BL, i}
Data unit:	Fraction
Description:	Methane correction factor for baseline wastewater treatment systems <i>i</i>
Source of data used:	Table III.H.1 from AMS III.H, Version 12 methodology
Value applied:	MCF _{ww, treatment, BL, i} = 0.8
Justification of the choice of data or description of measurement methods and procedures actually applied :	All MCF values have been chosen in a conservative manner according to table III.H.1 from methodology AMS III.H, Version 12. The baseline wastewater treatment system consists of cascading lagoons (with a depth of more than 2 metres) therefore MCF value is chosen as 0.8.
Any comment:	The original source of data can be checked for IPCC default value, as per Volume 5 Chapter 6, page 6.21. 2006 IPCC Guidelines for National Greenhouse Gas Inventories.

Data / Parameter:	MCF_{ww, treatment, PJ, k}
Data unit:	Fraction

Description:	Methane correction factor for project wastewater treatment system <i>k</i>
Source of data used:	Table III.H.1. of AMS III.H., Version 12
Value applied:	$MCF_{ww, treatment, PJ, i} = 0.8$
Justification of the choice of data or description of measurement methods and procedures actually applied :	The project wastewater treatment system without biogas recovery (secondary treatment) consists in a succession of deep lagoons, with depth more than 2 metres, so the value of 0.8 has been chosen.
Any comment:	IPCC Default values from chapter 6 of volume 5 page no 6.21. Waste in 2006 IPCC Guidelines for National Greenhouse Gas Inventories.

Data / Parameter:	$MCF_{ww, treatment, PJ, k}$
Data unit:	Fraction
Description:	Methane correction factor for project wastewater treatment system <i>k</i> equipped with biogas recovery
Source of data used:	Table III.H.1. of AMS III.H., Version 12
Value applied:	$MCF_{ww, treatment, PJ, i} = 0.8$
Justification of the choice of data or description of measurement methods and procedures actually applied :	The project wastewater treatment system with biogas recovery \ consists in UASB system, so the value of 0.8 has been chosen.
Any comment:	IPCC Default values from chapter 6 of volume 5 page no 6.21. Waste in 2006 IPCC Guidelines for National Greenhouse Gas Inventories.

Data / Parameter:	COD removal efficiency - baseline
Data unit:	%
Description:	Chemical oxygen demand removal efficiency of baseline treatment system
Source of data to be used:	Measured – Historical data based on colorimetric analysis
Value of data applied for the purpose of calculating expected emission reductions:	87.62%
Description of measurement methods and procedures to be applied:	The COD removal efficiency is based on historical COD measurements of the baseline system before implementation of project activity. A measurement campaign of 11 days has been conducted in order to determine the COD removal efficiency. The measured COD reduction across the baseline treatment system was 98.45% ⁴⁶ . As per AMS.III.H, Version 12, the value of 98.45% is multiplied by a factor of 0.89 for a conservative estimation of baseline emissions (due to uncertainty related to measurement campaign as opposed to one year historical data). The resulting COD removal efficiency factor of the baseline system is thus 87.62%

⁴⁶ COD measurement records have been submitted to the DOE.

	No.	Date	CODin (#1)	CODout (#8)	%COD removal
	1	28-Aug-04	20,260	243	98.8%
	2	11-Sep-04	25,975	519	98.0%
	3	12-Sep-04	27,875	306	98.9%
	4	13-Sep-04	23,800	209	99.1%
	5	14-Sep-04	23,900	239	99.0%
	6	15-Sep-04	24,160	375	98.4%
	7	16-Sep-04	19,660	420	97.9%
	8	17-Sep-04	20,320	540	97.3%
	9	25-Sep-04	20,660	433	97.9%
	10	26-Sep-04	21,160	277	98.7%
	11	1-Oct-04	24,920	271	98.9%
	AVG		22,971.82	348.36	98.45%
QA/QC procedures to be applied:	-				
Any comment:	-				

Data / Parameter:	CFE _{ww}
Data unit:	-
Description:	Capture efficiency of the biogas recovery equipment in the wastewater treatment systems
Source of data used:	Equation 12 in AMS III.H, Version 12 methodology (page 12)
Value applied:	0.9
Justification of the choice of data or description of measurement methods and procedures actually applied :	Default value as per AMS III.H.
Any comment:	-

Data / Parameter:	EF _{FF,CO2}
Data unit:	tCO ₂ /TJ
Description:	Emission factor of fossil fuel replaced – Residual Fuel oil
Source of data used:	IPCC 2006 default value for residual fuel oil, Volume 2, Chapter 1, 1.23
Value applied:	77.4 tCO ₂ /TJ
Justification of the choice of data or description of measurement methods and procedures actually applied :	IPCC default values used for unavailability of national data. In pre project scenario the residual fuel oil has been main source of thermal energy for the processes.
Any comment:	-

Data / Parameter:	EF _y
Data unit:	t CO ₂ /MWh
Description:	CO ₂ emission factor for grid power
Source of data used:	EGAT, EPPO Official published data from Electricity Generating Authority of Thailand (EGAT) and Energy Policy and Planning Office (EPPO)
Value applied:	0.521

Justification of the choice of data or description of measurement methods and procedures actually applied :	Fixed ex-ante based on tool for estimation of emission factor of an electricity system.
Any comment:	Conservative choice as compared to publically available data.

Data / Parameter:	D_{CH4}
Data unit:	Kg/m ³
Description:	Density of methane at normal conditions (T=273.15 K, p=101.325 kPa) of the biogas in the year y
Source of data used:	Tool to determine project emissions from flaring gases containing methane. http://cdm.unfccc.int/methodologies/Tools/eb28_repan13.pdf
Value applied:	0.716
Justification of the choice of data or description of measurement methods and procedures actually applied :	CDM EB as per EB28 Meeting report (Annex 13).
Any comment:	-

Data / Parameter:	η_{BL,thermal}
Data unit:	-
Description:	Efficiency of the boiler using fossil fuel that would have been used in the absence of the project activity
Source of data used:	Default factor as per AMS.I.C
Value applied:	100%
Justification of the choice of data or description of measurement methods and procedures actually applied :	Most conservative choice as per AMS.I.C
Any comment:	-

Data / Parameter:	NCV_{HFO}
Data unit:	TJ/tonne
Description:	NCV of fuel oil i.e. fossil fuel displaced by biogas
Source of data used:	IPCC default value
Value applied:	0.0404
Justification of the choice of data or description of measurement methods and procedures actually applied :	IPCC default value for heavy fuel oil as per 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2: Energy, Table 1.2.

Any comment:	
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The following are the parameters which are a part of monitoring plan and shall be monitored during crediting period:

Data / Parameter:	$Q_{ww, y}$
Data unit:	m^3
Description:	Volume of wastewater treated in year y
Source of data to be used:	Measured - Volumetric flow meters
Value of data applied for the purpose of calculating expected emission reductions in section B.5	For ex-ante estimation: 293,603 m^3
Description of measurement methods and procedures to be applied:	The volumetric flow meter for wastewater measurement is provided. The meter is a totalizer kind.
QA/QC procedures to be applied:	Periodic calibrations for flow meter are ensured. The meter is high accuracy magnetic kind. The SCADA readings from other internal wastewater flow meters within the UASB system are available for cross-checks in case of any malfunction. The readings reported during the day are cross-checked at end of day by plant manager.
Any comment:	-

Data / Parameter:	$COD_{ww, untreated, y}$
Data unit:	mg/l
Description:	COD of wastewater entering the treatment plant
Source of data to be used:	Measured – Colorimetric analysis
Value of data applied for the purpose of calculating expected emission reductions in section B.5	For ex-ante estimations: 22,972 mg/l (historical value)
Description of measurement methods and procedures to be applied:	The COD content will be analyzed using a colorimetric method in the on-site laboratory of the treatment plant. The results will be logged in the plant operation report on a daily basis.
QA/QC procedures to be applied:	The colorimetric method is well documented and well accepted either by national or international standards. Both colorimeter and chemical standard shall be tested regularly and test reports shall be available.
Any comment:	-

Data / Parameter:	$COD_{y, out, UASB}$
Data unit:	mg/l
Description:	COD of water exiting the UASB treatment process
Source of data to be used:	Measured – Colorimetric analysis
Value of data applied for the purpose of calculating expected emission reductions in section B.5	For ex-ante estimations: 2,297 mg/l Based on 90% UASB efficiency (Papop's technical proposal))
Description of measurement methods and procedures to be applied:	The COD content will be analyzed using a colorimetric method in the on-site laboratory of the treatment plant. The results will be logged in the plant operation report on a daily basis.

QA/QC procedures to be applied:	The colorimetric method is well documented and well accepted either by national or international standards. Both colorimeter and chemical standard shall be tested regularly and test reports shall be available.
Any comment:	-

Data / Parameter:	BG _{prod, y}
Data unit:	Nm ³
Description:	Amount of biogas produced by the digester
Source of data to be used:	Measured using gas flow meter
Value of data applied for the purpose of calculating expected emission reductions in section B.5	For ex-ante estimations: 2,146,193
Description of measurement methods and procedures to be applied:	The gas flow meters with an accepted level of accuracy has been installed and integrated with the SCADA system (Supervisory Control And Data Acquisition system) at the plant, providing continuous measurements of the total biogas volume produced by the UASB system. Volumetric flow meters has been automatically measured temperature and pressure, expressing biogas volumes in normalized cubic meters (Nm ³).
QA/QC procedures to be applied:	The flow meter shall be subject to periodic calibration according to the equipment's specifications and applicable industrial standards. In case of monitoring information gaps or malfunction of this meter, information from other biogas flow meters can be used for determination (only if applied in a conservative manner) or crosschecking of this parameter by application of a mass balance approach over the entire biogas system.
Any comment:	-

Data / Parameter:	W _{CH4}
Data unit:	%
Description:	Methane content in the biogas in the year y
Source of data to be used:	Measured using methane analyser
Value of data applied for the purpose of calculating expected emission reductions in section B.5	A value of 65% is used for estimations (in line with technical proposal of UASB system).
Description of measurement methods and procedures to be applied:	The fraction of methane in the biogas shall be measured with a continuous analyzer, or alternatively, with periodical measurements ensuring a 95% confidence level.
QA/QC procedures to be applied:	For methane analyzer, the project proponent shall ensure proper calibration of same regularly.
Any comment:	A continuous methane analyser was not part of the initial design of the plant but will be incorporated in order to comply with monitoring requirements.

Data / Parameter:	BG _{TOFlare, y} / FV _{RG, h}
Data unit:	Nm ³
Description:	Amount of biogas (volumetric flow) sent to the flare system
Source of data to be used:	Measured using gas flow meter
Value of data applied for the purpose of calculating	For ex-ante estimations: 0 Nm ³ /year Since the energy requirement of the starch plant is higher than

expected emission reductions in section B.5	the energy content of the biogas that can be delivered as per ex-ante calculations, it is assumed that no biogas would be flared.
Description of measurement methods and procedures to be applied:	The gas flow meters with an accepted level of accuracy shall be installed and integrated with the SCADA system (Supervisory Control And Data Acquisition system) at the plant, providing continuous measurements of the total biogas volume sent to the flare system. Volumetric flow meters shall automatically measure temperature and pressure, expressing biogas volumes in normalized cubic meters (Nm³)
QA/QC procedures to be applied:	The flow meter shall be subject to periodic calibration according to the equipment's specifications and applicable industrial standards. In case of monitoring information gaps or malfunction of this meter, information from other biogas flow meters can be used for determination (only if applied in a conservative manner) or crosschecking of this parameter by application of a mass balance approach over the entire biogas system.
Any comment:	A continuous biogas flow meter prior to the flare system was not part of the initial design of the plant but will be incorporated in order to comply with monitoring requirements.

Data / Parameter:	$\eta_{\text{flare-h}}$
Data unit:	%
Description:	Flare efficiency
Source of data to be used:	Default value for open flares as per "Tool to determine project emissions from flaring gases containing methane" and flame detection records from
Value of data applied for the purpose of calculating expected emission reductions:	50% default factor for an open flare
Description of measurement methods and procedures to be applied:	The efficiency of the flaring process is defined as 50% based on the default factor for open flares. The default factor of 50% might be only applied if a flame is detected at the flare for more than 20 minutes in hour h, whenever biogas is sent to the flare system. If the biogas is sent to the flare for a period shorter than one hour, the flare detection signal shall be available for at least 1/3 of this period, following the same logic of the flaring tool (20 minutes out of 1 hour). If these conditions are not met, 0% default value should be used for this period. The flame detection signals shall be recorded electronically on a continuous basis. A comparison of the time stamp of the flame detection signal to the time stamp of biogas flow meter records as per SCADA records, measuring the biogas flow into the flare system, shall be used as basis for calculation of the flame detection time period. Other flare specific parameters, which might be required to monitor whether the flare operates within the specified range of operating conditions shall be monitored according to the manufacturer's specifications.
QA/QC procedures to be	Maintenance of the flare system shall be conducted periodically

applied:	as per supplier's specifications to ensure optimal operation.
Any comment:	-

Data / Parameter:	BG _{combusted, y}
Data unit:	Nm ³
Description:	Amount of biogas sent to boiler in the year y
Source of data to be used:	Measured using gas flow meter
Value of data applied for the purpose of calculating expected emission reductions in section B.5	For ex-ante estimations: 1,972,073 Nm ³ /year Since the energy requirement of the starch plant is higher than the energy content of the biogas that can be delivered as per ex-ante calculations, it is assumed that 90% of the available biogas would be combusted in the boilers (10% of leakage in the UASB).
Description of measurement methods and procedures to be applied:	The gas flow meters with an accepted level of accuracy has been installed and integrated with the SCADA system (Supervisory Control And Data Acquisition system) at the plant, providing continuous measurements of the total biogas volume sent to the boiler system. Volumetric flow meters shall automatically measure temperature and pressure, expressing biogas volumes in normalized cubic meters (Nm ³)
QA/QC procedures to be applied:	The flow meter shall be subject to periodic calibration according to the equipment's specifications and applicable industrial standards. In case of monitoring information gaps or malfunction of this meter, information from other biogas flow meters can be used for determination (only if applied in a conservative manner) or crosschecking of this parameter by application of a mass balance approach over the entire biogas system.
Any comment:	-

Data / Parameter:	EC _y
Data unit:	MWh
Description:	Electricity from the grid consumed by the project activity (wastewater treatment, biogas recovery and biogas utilisation/flaring systems)
Source of data to be used:	Electricity transmission meter provided at point of supply to entire wastewater treatment plant.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Ex-ante estimations: 456,560 kWh or 456.56 MWh (Maximum consumption as per Papop design proposal) Ex-post estimation: the electricity consumption will use the actual data from electricity bill from PEA.
Description of measurement methods and procedures to be applied:	Electricity consumption shall be monitored continuously by an electricity meter.
QA/QC procedures to be applied:	The electricity meter shall be subject to periodic calibration according to the equipment's specifications and applicable industrial standards. In the absence of electric meter for the electricity consumption of project activity, maximum rated consumption shall be used to calculate the emissions from PE _{power, y} , as follows: the rated capacity of auxiliary equipment of the wastewater treatment plant shall be multiplied by 8760 hours and a factor of 1.1 in order to account for 10%

	transmission losses.
Any comment:	PEA will maintain the accuracy of monitoring equipment

Data / Parameter:	$S_{final, PJ, y}$
Data unit:	Tonnes/ and type of application
Description:	Amount of final sludge generated by the wastewater treatment in the year y and type of application/disposal.
Source of data to be used:	Sludge profile in case of any produced sludge is being taken out of the plant. Weighing equipment available at site are used before using the material for any other purpose
Value of data applied for the purpose of calculating expected emission reductions in section B.5	For ex-ante estimations: 0
Description of measurement methods and procedures to be applied:	Whenever sludge is removed from the reactor the practice of final disposal shall be monitored by keeping written evidence of the amount of sludge removes and its application. Monitoring of the final application shall be used to determine whether the final sludge disposal is either aerobic or anaerobic.
QA/QC procedures to be applied:	Plant manager's signature is required on the record.
Any comment:	The UASB reactor is not supposed to produce any sludge. Only if the suspended solid concentration in the wastewater is too high, sludge production might require periodic removals. In addition, the removed sludge will be taken out of the plant by the technology provider and a sludge profile is kept to keep track of such process.

Data / Parameter:	$EG_{thermal, y}$
Data unit:	TJ/year
Description:	Net quantity of thermal energy supplied by the dual fuel operated boiler (using biogas and HFO) after implementation of the project activity. The value is calculated based on measurements of operational parameters of the boiler as described below.
Source of data to be used:	Measurements of the thermal oil flow rate and of the temperature difference of the thermal oil before and after the boiler.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	83.55 TJ/year Based on historical data
Description of measurement methods and procedures to be applied:	$EG_{thermal, y}$ is calculated as follows: $EG_{thermal, y} = \sum (T_{out} - T_{in}) \times Q_{oil, h} \times C_{oil}$ Where: T_{out} Temperature of heating medium (thermal oil) coming out of boiler T_{in} Temperature of heating medium (thermal oil) going into the boiler $Q_{oil, h}$ Flow rate of thermal oil (kg)

	C oil Specific heat of oil in KJ/kg. K as per technical specifications
QA/QC procedures to be applied:	The temperature and flow rate meters shall be subject to periodic calibration according to the equipment's specifications and applicable industrial standards. In the absence of monitoring data or gaps in monitoring procedures, $EG_{thermal,y}$ can be estimated in a conservative manner by an energy balance calculation based on the energy inputs to the boiler system (biogas flow, HFO consumption), assuming a conservative value of 100% for the efficiency of the boiler. The amount of starch dried in a certain period can be used for crosschecking purposes.
Any comment:	-

Data / Parameter:	$FC_{HFO,y}$
Data unit:	Tones/year
Description:	Quantity of fossil fuel co-fired or fired along with biogas during year y.
Source of data to be used:	Measured by continuous flow meter registering fuel consumption by the boiler system.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	932 t/year (This value is based on the heat requirement by the starch plant that cannot be met by the biogas supply).
Description of measurement methods and procedures to be applied:	A proper record of all the fossil fuel consumed shall be maintained at the project site.
QA/QC procedures to be applied:	Fuel consumption can be cross checked against the fuel oil quantities purchased and stock records.
Any comment:	This is a very conservative estimate based on 100% efficiency of replacement; the proponent foresees consumption of fuel oil in future along with biogas but this assumption is conservative for the IRR estimations.

3.4 Description of the monitoring plan

1. Monitoring Management

The required monitoring equipment is installed and regularly calibrated by the project's developer (Papop Renewable Co., Ltd.) acting as the turn-key operator. Flow meters are regularly calibrated to recognize procedures by the operator (who is also the turn-key supplier of technology) and sampling is carried out by the onsite biogas plant operator under the plant manager supervisory according to appropriate industrial standards.

Data acquisition for the gas and wastewater flow meters is executed through the process control unit of the biogas plant and the plant operations software. Lab data is fed into the operations software through a manual data entry user interface.

The biogas plant is operated by four operators (working in 3 shifts a day) who also collect data under the supervision of the assistant plant manager who is in charge of filing and processing data and report directly to biogas plant manager. All biogas plant staffs are trained by the Papop Company prior to full commissioning of biogas plant. Figure 2 outlines the structure of operational and management of the project activity.

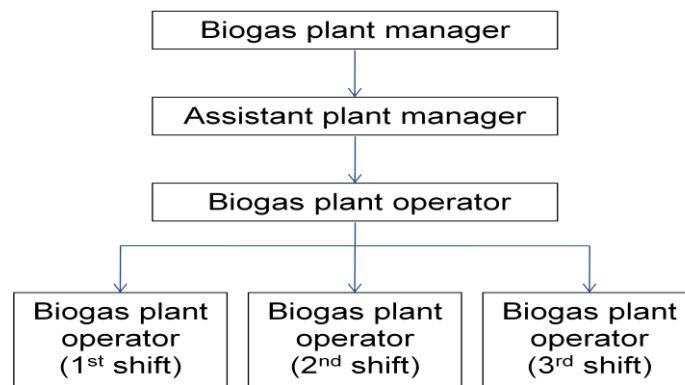


Figure 6: The structure of operational and management of the project activity

2. Quality Assurance and Quality Control

The biogas plant manager monitors overall performance of the plant, ensures proper and timely calibration, data acquisition and storage.

3. On-site Procedures

The operations software creates daily logs of plant performance which are printed out and recorded electronically for periodic download onsite or remote transfer for further processing.

Procedures for Calibration of Equipment

The biogas plant operators carry out calibration according to international standards.

4. Data Storage and Filing – Electric Workbook

All relevant data is stored electronically in excel sheets. The monitoring records shall be archived for a period of crediting period + 2 years.

4 GHG Emission Reductions:

4.1 Explanation of methodological choice:

Ex-ante estimations of emission reductions:

Identified baseline for the project activity is anaerobic open lagoons without methane recovery system and consumption of heavy fuel oil for heat generation at the starch plant.

Emission reduction calculations are split in two parts, (A) methane avoidance component according to AMS III.H Version 12, and (B) heat generation component according to AMS.I.C , Version 14.

I.A. Baseline emissions as per AMS.III.H:

According to the paragraph 16 of AMS III.H, baseline emissions for the systems affected by the project activity may consist of:

- (i) Emissions on account of electricity or fossil fuel used ($BE_{power,y}$);
- (ii) Methane emissions from baseline wastewater treatment systems ($BE_{ww,treatment,y}$);
- (iii) Methane emissions from baseline sludge treatment systems ($BE_{s,treatment,y}$);
- (iv) Methane emissions on account of inefficiencies in the baseline wastewater treatment systems and presence of degradable organic carbon in the treated wastewater discharged into river/lake/sea ($BE_{ww,discharge,y}$);
- (v) Methane emissions from the decay of the final sludge generated by the baseline treatment systems ($BE_{s,final,y}$).

Baseline emissions (BE_y)

The baseline emissions are calculated as follows.

$$BE_y = \{BE_{power,y} + BE_{ww,treatment,y} + BE_{s,treatment,y} + BE_{ww,discharge,y} + BE_{s,final,y}\} \quad (1)$$

Where,

Parameter	Details
BE_y	Baseline emissions in year y (tCO ₂ e)
$BE_{power,y}$	Baseline emissions from electricity or fuel consumption in year y (tCO ₂ e)
$BE_{ww,treatment,y}$	Baseline emissions of the wastewater treatment systems affected by the project activity in year y (tCO ₂ e)
$BE_{s,treatment,y}$	Baseline emissions of the sludge treatment systems affected by the project activity in year y (tCO ₂ e)
$BE_{ww,discharge,y}$	Baseline methane emissions from degradable organic carbon in treated wastewater discharged into sea/river/lake in year y (tCO ₂ e).
$BE_{s,final,y}$	Baseline methane emissions from anaerobic decay of the final sludge produced in year y (tCO ₂ e). If the sludge is controlled combusted, disposed in a landfill with biogas recovery, or used for soil application in the baseline scenario, this term shall be neglected.

Baseline emissions of the wastewater treatment systems affected by the project activity:

Methane emissions from the baseline wastewater treatment systems affected by the project ($BE_{ww,treatment,y}$) are determined using the methane generation potential of the wastewater

treatment systems as per the paragraph 20 of AMS III.H version 12. The following equation is used.

$$BE_{ww, treatment, y} = \sum_i Q_{ww, i, y} * COD_{removed, i, y} * MCF_{ww, treatment, BL, i} * B_{o, ww} * U_{BL} * GWP_{CH4} \quad (2)$$

Where,

Parameter	Details
$BE_{ww, treatment, y}$	Baseline emissions of the wastewater treatment systems affected by the project activity in year y (tCO ₂ e)
$Q_{ww, i, y}$	Volume of wastewater treated in baseline wastewater treatment system i in year y (m ³)
$COD_{removed, i, y}$	Chemical oxygen demand removed by baseline treatment system i in year y (tonnes/m ³) measured as the difference between inflow COD and the outflow COD in system i
$MCF_{ww, treatment, BL, i}$	Methane correction factor for the baseline anaerobic wastewater treatment i (MCF values as per table III.H.1)
i	Index for baseline wastewater treatment system
$B_{o, ww}$	Methane producing capacity of the wastewater (IPCC lower value for domestic wastewater of 0.21 kg CH ₄ /kg COD) ⁴⁸
U_{BL}	Model correction factor to account for model uncertainties (0.94) ⁴⁹
GWP_{CH4}	Global Warming Potential for methane (value of 21)

Baseline emission from electricity and fuel consumptions ($BE_{power, y}$)

The only electricity consumption devices used in the baseline wastewater treatment systems are pumps for pumping the wastewater from the starch factory into the open anaerobic lagoons. There is no consumption of fossil fuels for the operation of the baseline system. Please note that consumption of fossil fuels for heat generation at the starch plant are considered in the emission reduction component as per AMS.I.C.

For the sake of simplification and conservativeness, baseline emissions from electricity and fuel consumptions ($BE_{power, y}$) are assumed to be zero.

$$BE_{power, y} = 0$$

Baseline emission from wastewater discharge ($BE_{ww, discharge, y}$)

In the baseline scenario, treated wastewater is not discharged into sea/lake/river, therefore methane emissions from degradable organic carbon in treated wastewater discharged ($BE_{ww, discharge, y}$) in e.g. a river, sea or lake in the baseline situation is assumed to be zero.

$$BE_{ww, discharge, y} = 0$$

Baseline emissions of the sludge treatment systems affected by the project ($BE_{s, treatment, y}$)

There is no sludge treatment system in the baseline scenario, only a wastewater treatment system based on open anaerobic lagoons, hence baseline emissions from sludge treatment are not taken into consideration.

⁴⁸ The IPCC default value of 0.25 kg CH₄/kg COD was corrected to take into account the uncertainties. Project activities may use the default value of 0.6 kg CH₄/kg BOD, in case the parameter BOD_{5,20} is used to determine the organic content of the wastewater. In this case, baseline and project emissions calculations shall use BOD instead of COD in the formulas, and the monitoring of the project activity shall be based in direct measurements of BOD_{5,20}, i.e., the estimation of BOD values based on COD measurements is not allowed.

⁴⁹ Reference: FCCC/SBSTA/2003/10/Add.2, page 25.

Baseline emissions from final sludge disposal ($BE_{s, final, y}$)

For the sake of conservativeness, it is assumed that the sludge is used for soil application in the baseline scenario. Therefore baseline methane emissions from anaerobic decay of the final sludge ($BE_{s, final, y}$) produced is also neglected.

$$BE_{s, final, y} = 0$$

I.B. Baseline emissions as per AMS.I.C:

As per paragraph 15 of AMS I.C, for steam/heat produced using fossil fuels the baseline emissions are calculated as follows:

$$BE_{thermal, CO_2, y} = (EG_{thermal, y} / \eta_{BL, thermal}) * EF_{FF, CO_2} \quad (3)$$

Where:

Parameter	Details
$BE_{thermal, CO_2, y}$	the baseline emissions from steam/heat displaced by the project activity during the year y in tCO_2e
$EG_{thermal, y}$	the net quantity of steam/heat supplied by the project activity during the year y in TJ.
EF_{FF, CO_2}	the CO_2 emission factor per unit of energy of the fuel that would have been used in the baseline plant in (tCO_2 / TJ), obtained from reliable local or national data if available, otherwise, IPCC default emission factors are used.
$\eta_{BL, thermal}$	the efficiency of the plant using fossil fuel that would have been used in the absence of the project activity

The baseline emissions for ex-ante estimations are based on historical specific consumption of fossil fuel oil per tonne of starch. The future expected starch production is used to estimate the baseline emissions for ex ante purpose. In case of ex-post calculations, the amount of energy delivered by the dual fuel fired boiler is used to estimate the baseline emissions.

II.A Project emissions as per AMS.III.H:

As per the paragraph 26 of AMS III.H, Project activity emissions from the systems affected by the project activity are:

- (i) CO_2 emissions on account of power and fuel used by the project activity facilities ($PE_{power, y}$);
- (ii) Methane emissions from wastewater treatment systems affected by the project activity, and not equipped with biogas recovery in the project situation ($PE_{ww, treatment, y}$);
- (iii) Methane emissions from sludge treatment systems affected by the project activity, and not equipped with biogas recovery in the project situation ($PE_{s, treatment, y}$);
- (iv) Methane emissions on account of inefficiency of the project activity wastewater treatment systems and presence of degradable organic carbon in treated wastewater ($PE_{ww discharge, y}$);
- (v) Methane emissions from the decay of the final sludge generated by the project activity treatment systems ($PE_{s, final, y}$);
- (vi) Methane fugitive emissions on account of inefficiencies in capture systems ($PE_{fugitive, y}$);
- (vii) Methane emissions due to incomplete flaring ($PE_{flaring, y}$);

(viii) *Methane emissions from biomass stored under anaerobic conditions which does not take place in the baseline situation ($PE_{biomass, y}$).*

$$PE_y = \{PE_{power, y} + PE_{ww, treatment} + PE_{s, treatment} + PE_{ww discharge, y} + PE_{s, final, y} + PE_{fugitive, y} + PE_{biomass, y} + PE_{flaring, y}\} \quad (4)$$

Where,

Parameter	Details
PE_y	Project emissions in year y (tCO ₂ e)
$PE_{power, y}$	Emissions from electricity or fuel consumption in the year y (tCO ₂ e)
$PE_{ww, treatment, y}$	Methane emissions from wastewater treatment systems affected by the project activity, and not equipped with biogas recovery in the project situation (tCO ₂ e)
$PE_{s, treatment, y}$	Methane emissions from sludge treatment systems affected by the project activity, and not equipped with biogas recovery in the project situation (tCO ₂ e)
$PE_{ww discharge, y}$	Methane emissions on account of inefficiency of the project activity wastewater treatment systems and presence of degradable organic carbon in treated wastewater
$PE_{s, final, y}$	Methane emissions from the decay of the final sludge generated by the project activity treatment systems (tCO ₂ e)
$PE_{fugitive, y}$	Methane emissions from biogas release in capture systems in year y (tCO ₂ e)
$PE_{biomass, y}$	Methane emissions from biomass stored under anaerobic conditions (tCO ₂ e)
$PE_{flaring, y}$	Methane emissions due to incomplete flaring in year y (tCO ₂ e)

Emissions from electricity consumption ($PE_{y, power}$)

Emissions from electricity consumption by the project activity facilities are calculated according to the paragraph 19 of AMS III.H as given below.

$$PE_{Power, y} = EC_y * EF_y \quad (5)$$

Where,

Parameter	Details
$PE_{y, power}$	Emissions from electricity consumption in the year y (tCO ₂ e)
EC_y	Electricity from the grid consumed by the project activity (wastewater treatment, biogas recovery and biogas utilisation/flaring systems) (MWh)
EF_y	Thailand National Grid emission factor (tCO ₂ e/MWh)

Emissions from degradable organic carbon in treated wastewater ($PE_{y, ww, treated}$)

Methane emissions from wastewater treatment systems affected by the project activity, and not equipped with biogas recovery in the project situation are calculated as per equation 2/paragraph 20 in AMS.III.H using an uncertainty factor of 1.06. The following equation is used.

$$PE_{ww, treatment, y} = \sum Q_{ww, k, y} * COD_{removed, PJ, k, y} * MCF_{ww, treatment, PJ, k} * B_{o, ww} * UF_{PJ} * GWP_{CH4} \quad (6)$$

Where,

Parameter	Details
$PE_{ww, treatment, y}$	Emissions from degradable organic carbon in treated wastewater in year y (tCO ₂ e)
$Q_{ww, k, y}$	Volume of wastewater treated in project wastewater treatment system k in year y (m ³)
$COD_{y, removed, PJ, k}$	Chemical oxygen demand removed by project wastewater treatment system k in year y (tonnes/m ³), measured as the difference between inflow COD and the outflow COD in system k
$B_{o, ww}$	Methane producing capacity of the wastewater (IPCC default value of 0.21 kg CH ₄ /kg COD)
$MCF_{ww, treatment, PJ, k}$	Methane correction factor for project wastewater treatment system k
UF_{PJ}	Model correction factor for uncertainties (1.06)
GWP_{CH4}	Global Warming Potential for methane (value of 21 is used)

Methane emissions from sludge treatment systems ($PE_{s, treatment, y}$)

The project activity does not include sludge treatment system, therefore the emission from sludge treatment system are not taken into consideration.

Methane emissions on account of inefficiency of the project activity wastewater treatment systems and presence of degradable organic carbon in treated wastewater ($PE_{ww discharge y}$)

In the project activity the treated wastewater will be discharged in existing open lagoons and there will be no discharge to river, sea or lake. Hence, emissions from this component have not been included in the assessment.

Methane emissions from the decay of the final sludge generated by the project activity treatment systems ($PE_{s, final, y}$):

A relatively small amount of final sludge will be removed from the digester. The project proponent will apply final sludge for field application as fertilizer and the final disposal of the sludge shall be monitored during the crediting period. Therefore as suggested by the AMS III.H, the emission from anaerobic decay from the final sludge produced can be omitted.

Methane fugitive emissions on account of inefficiencies in capture systems ($PE_{fugitive y}$)

Project activity emissions from methane release in capture systems are determined as per paragraph 27 of AMS III.H as given below.

$$PE_{fugitive, y} = PE_{fugitive, ww, y} + PE_{fugitive, s, y} \quad (7)$$

Where,

Parameter	Details
$PE_{fugitive, y}$	Emissions from methane release in capture and utilization/combustion/flare \systems in year y (tCO ₂ e)
$PE_{fugitive, ww, y}$	Fugitive emissions through capture inefficiencies in the anaerobic wastewater treatment systems in the year y (tCO ₂ e)
$PE_{y, fugitive, s}$	Fugitive emissions through capture inefficiencies in the anaerobic sludge treatment systems in the year y (tCO ₂ e)

a. Fugitive emissions through capture inefficiencies in the anaerobic wastewater treatment ($PE_{fugitive, ww, y}$)

These emissions are calculated as follows;

$$PE_{fugitive\,ww,y} = (1 - CEF_{ww}) * MEP_{ww,treatment,y} * GWP_{CH4} \quad (8)$$

Where,

Parameter	Details
CEF_{ww}	Capture efficiency of the biogas recovery equipment in the wastewater treatment systems (a default value of 0.9 shall be used)
$MEP_{ww,treatment,y}$	Methane emission potential of wastewater treatment systems equipped with biogas recovery system in year y (tonnes)

$$MEP_{ww,treatment,y} = Q_{ww,y} * B_{o,ww} * UF_{PJ} * \sum_k COD_{removed,PJ,k,y} * MCF_{ww,treatment,PJ,k} \quad (9)$$

Where,

Parameter	Details
$Q_{ww,y}$	Volume of wastewater treated in project wastewater treatment system k in year y (m ³ /year)
$B_{o,ww}$	Methane producing capacity of the wastewater
UF_{PJ}	Model correction factor to account for model uncertainties (1.06)
$COD_{removed,PJ,k,y}$	The chemical oxygen demand removed by the treatment system k of the project activity equipped with biogas recovery in the year y (tonnes/m ³)
$MCF_{ww,treatment,PJ,k}$	Methane correction factor for the project wastewater treatment system k equipped with biogas recovery equipment (MCF values as per table III.H.1)

b. **Fugitive emissions through capture inefficiencies in the anaerobic sludge treatment systems in the year y ($PE_{y,fugitive,s}$) :**

Sludge will be used only for land application, therefore no sludge treatment envisaged in the project activity. Therefore emission from sludge treatment is not taken into consideration.

Methane emissions due to incomplete flaring ($PE_{flaring,y}$)

Methane emissions due to incomplete flaring in year y are calculated as per the “Tool to determine project emissions from flaring gases containing methane” (tCO₂e). The project proponent has installed an open flaring system. For the determination of the flare efficiency, the default value of 50% will be used for the ex-ante calculation of project emissions from flaring gases. The ex-post factor to be used for flare efficiency is subject to monitoring requirements as described in Section 3.3.

“Tool to determine project emissions from flaring gases containing methane” (hereafter the flaring tool) is referred to determine the project emissions from flaring of the biogas gas stream (called residual gas stream in the flaring tool).

The determination of the hourly flare efficiency depends on the operation of the flare (e.g. temperature), the type of flare used (open or enclosed).

In case of open flares, the flare efficiency in the hour h ($\eta_{flare,h}$) is:

- 0% if the flame is not detected for more than 20 minutes during the hour h
- 50%, if the flame is detected for more than 20 minutes during the hour h

For ex-ante calculations, the 50% default is applied. Ex-post calculations will be based on the monitored period of flare activity as described above.

Methane emissions from biomass stored under anaerobic conditions which does not take place in the baseline situation ($PE_{biomass, y}$).

Biomass storage is not envisaged in the project activity. Therefore methane emissions from biomass stored under anaerobic conditions are not taken into consideration.

II.B Project emissions as per AMS.I.C:

According to paragraph 24 of AMS-I.C, CO₂ emissions from on-site consumption of fossil fuels due to the project activity shall be calculated using the latest version of “Tool to calculate project or leakage CO₂ emissions from fossil fuel combustion”.

$$PE_{FC, y} = FC_{HFO, y} * NCV_{HFO} * EF_{HFO, CO_2} \quad (10)$$

Parameter	Details
$PE_{FC, y}$	Project emissions due to combustion of fossil fuel in year y (tCO ₂ e)
$FC_{HFO, y}$	Amount of fossil used in the boiler in ton/yr
NCV_{HFO}	NCV of fossil fuel used in the process (0.0404 TJ/tonne)
EF_{HFO, CO_2}	Emission factor of Heavy fuel oil as per IPCC (77.4 tCO ₂ /TJ)

The ex-ante estimation of project emissions is based on the expected fuel oil quantity that would be utilized in the project activity after partial replacement of fuel oil by biogas.

For ex-post estimations, the fossil fuel consumption at the project site shall be monitored for estimation of project emissions.

III. Leakage emissions (LE_y) as per AMS.III.H and AMS.I.C:

The used technology is not equipment transferred from another activity, therefore according to AMS.III.H and AMS.I.C, there is no leakage to be considered.

IV.A Emission Reductions (ER_y) as per AMS.III.H:

As per the paragraph 29 of AMS III.H, emission reduction are estimated *ex ante* in the VCS PD using formulas mentioned in baseline, project and leakage emissions sections above. Emission reductions are estimated *ex-ante* as follows;

$$ER_{y, ex-ante} = BE_{y, ex-ante} - (PE_{y, ex-ante} + LE_{y, ex-ante}) \quad (11)$$

Where,

Parameter	Details
$ER_{y, ex-ante}$	<i>Ex ante</i> emission reduction in year y (tCO ₂ e)
$BE_{y, ex-ante}$	<i>Ex ante</i> baseline emissions in year y (tCO ₂ e)
$PE_{y, ex-ante}$	<i>Ex ante</i> project emissions in year y (tCO ₂ e)
$LE_{y, ex-ante}$	<i>Ex ante</i> leakage emissions in year y (tCO ₂ e)

According to the paragraph 31 AMS III.H, emission reduction 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. Emission reductions achieved on any year are the lowest value of the following;

$$ER_{y, ex-post} = \min(BE_{y, ex-post} - PE_{y, ex-post} - LE_{y, ex-post}), (MD_y - PE_{power, y} - PE_{biomass, y} - LE_{y, ex-post}) \quad (12)$$

Where,

Parameter	Details
$ER_{y, ex-post}$	Emission reductions achieved by the project activity based on monitored values for year y (tCO ₂ e)
$BE_{y, ex-post}$	Baseline emissions calculated as per paragraph <i>ex post</i> monitored values
$PE_{y, ex-post}$	Project emissions calculated as per paragraph <i>ex post</i> monitored values
MD_y	Methane captured and destroyed/gainfully used by the project activity in the year y

As per paragraph 32 in AMS III.H., in case of flaring/combustion MD_y will be measured using the conditions of the flaring process:

$$MD_y = BG_{burnt, y} * w_{CH_4, y} * D_{CH_4} * FE * GW_{P_{CH_4}} \quad (13)$$

Where:

Parameter	Details
$BG_{burnt, y}$	Biogas flared/combusted in year y (m ³)
w_{CH_4}	Methane content in the biogas in the year y (mass fraction)
D_{CH_4}	Density of methane at the temperature and pressure of the biogas in the year y (tonnes/m ³)
FE	Flare efficiency in year y (fraction)

IV.B Emission Reductions (ER_y) as per AMS.I.C:

As per paragraph 28 of AMS.I.C, emission reductions are calculated as follows:

$$ER_y = BE_y - PE_y - LE_y \quad (14)$$

BE_y , PE_y and LE_y as per AMS.I.C are defined in the sections I.B, II.B and III above.

4.2 Quantifying GHG emissions and/or removals for the baseline scenario:

Based on the calculation approach outlined above, ex-ante baseline emissions of the project activity are quantified as follows:

Baseline Emissions as per AMS.III.H

	Design capacity of Starch mill	300	t/day	Design data- see design proposal (papop company)
	Starch Production	63,005	tonnes/year	Three years avg. of 2002-2004 (before project starting date)
	Wastewater generation	4.7	m3/t	Based on Data for 2006 to 2008
	Wastewater flow - (design / historical data) - $Q_{ww,y}$	293,603	m3/year	
	$COD_{ww,untreated,y}$	22,972	mg/l	
	Efficiency of lagoon system - COD removal	87.62%		Lagoon Efficiency
	COD out - based on baseline system efficiency	2,843	mg/l	
	Model correction factor - UF_{BL}	0.94		
	COD removal - baseline	0.020129	t/m3	
	$B_{o,ww}$	0.21	tCH4/tCOD	
	$MCF_{ww,treatment,BL,i}$	0.8		
	GWP_{CH4}	21		
BE_{ww,y}	For Methane Generation - AMS III.H	19,599	tCO₂ e/year	

	COD removal efficiency of UASB system	90%		Design data - see design proposal (papop company)
	COD out - project activity	2,297	mg/l	
	COD removed - anaerobic	0.0207	kg/m3	

Baseline Emissions as per AMS.I.C

	Thermal energy requirement of starch plant	83.55	TJ/year	Based on historical data
	Efficiency of HFO boiler	100%		Conservative assumption as per AMS.I.C
	NCV of Residual Fuel Oil (NCV_{HFO})	0.0404	TJ/tonne	IPCC default
	Emission Factor of Residual Fuel Oil	77.4	tCO ₂ /TJ	IPCC default
BE_{thermal,i}	Fuel replacement - AMS I C	6,464	tCO₂e/year	

4.3 Quantifying GHG emissions and/or removals for the project:

Ex ante estimation of project emissions as per AMS.III.H:

Project Emissions as per AMS.III.H

	Rated power capacity	69	kWh
	Annual Power Consumption	456.56	MWh/year
	Grid emission factor	0.521	tCO ₂ /MWh
PE_{power,y}	For Power Consumption	238	tCO₂e/year

	Wastewater flow - (design / historical data) - Q _{ww,y}	293,603	m ³ /year
	COD of treated waste water	0.0023	t/m ³
	COD - reduction in open lagoon	87.6%	
	B _{o, ww}	0.21	tCH ₄ /tCOD
	UF _{pj} - Model correction factor	1.06	
	MCF _{ww, treatment, PJ, k}	0.8	
PE_{ww, treated}	Emissions in treated waste water	2,210	tCO₂e/year

	Amount of final sludge generated	0	tonnes
	DOC - Sludge	0.09	
	MCF - Landfill (receiving sludge)	0	
	DOC _f	0.5	
	F	0.5	
PE_{s,final,y}	Decay of final Sludge	0	tCO₂e/year

	CFE - ww	0.9	
	Methane emission pot. of UASB system	1,081	t CH ₄ /year
PE_{fugitive,y}	Fugitive Emissions - WW	2,270	tCO₂e/year

	Fraction of biogas expected to be flared	0%	
	Biogas to be flared ($BG_{ToFlare,y}$)	0	Nm ³ /year
	Flare efficiency	50%	
PE_{flare, y}	Flaring Emissions	0	tCO₂e/year

Ex-ante estimation of project emissions as per AMS.I.C:

Project Emissions as per AMS.I.C

	HFO consumption in project scenario	932	tonne/year
	NCV of Residual Fuel Oil (NCV_{HFO})	0.0404	TJ/tonne
	Energy content of HFO consumed	37.6	TJ/year
	Emission Factor of Residual Fuel Oil	77.4	tCO ₂ /TJ
PE_{FC,y}	Emissions from fossil fuel consumption	2,913	tCO₂e/year

As mentioned in Section 4.2, no leakage emissions are considered.

4.4 Quantifying GHG emission reductions and removal enhancements for the GHG project:

Total emission reductions (tonnes CO ₂ e)				
year	Emission of project activity emissions (tonnes CO ₂ e)	Estimation of baseline emissions (tonnes CO ₂ e)	Estimation of leakage (tonnes CO ₂ e)	Estimation of overall emission reductions (tonnes CO ₂ e)
1	7,631	26,063	0	18,432
2	7,631	26,063	0	18,432
3	7,631	26,063	0	18,432
4	7,631	26,063	0	18,432
5	7,631	26,063	0	18,432
6	7,631	26,063	0	18,432
7	7,631	26,063	0	18,432
8	7,631	26,063	0	18,432
9	7,631	26,063	0	18,432
10	7,631	26,063	0	18,432
Total (tonnes CO₂e)	76,308	260,632	0	184,324

A complete excel data sheet summarizing all ERs calculations has been provided to the DOE. The results are summarized below:

5 Environmental Impact:

The project being a renewable energy biogas based thermal project does not fall under the purview of the Environmental Impact Assessment (EIA) notification of the Ministry of Natural Resources and Environment (MONRE). The Government of Thailand with the approval of National Environment Board (NEB), has the power to specify notification for the type and size of projects or activities requiring EIA, which is currently regulated by Section 46 of the Enhancement and Conservation of Nation from the National Environmental Quality Act 1992.

6 Stakeholder comments:

Oral hearing for local stakeholders:

Invitation procedure

The Stakeholder Consultation has been conducted by the project owner SD Biosupply Co., Ltd. with assistance from South Pole Carbon Asset Management Limited (Switzerland based company responsible for VER project development).

Stakeholder groups have been identified and informed through oral mean about the meetings.

Place and date of the meetings

The stakeholder consultation was held at communities around the starch plant on 22nd July 2008. Thus, all participants were able to examine the location where the proposed project will take place.

Meeting Participants

The mentioned meeting was attended by local residents and representatives from the following stakeholder categories:

1. Local residents
2. Local government representatives
3. Delegates from political parties
4. Local entrepreneurs
5. Employees

18 participants have followed the invitation and attended the meeting.

Language

Documentation and meeting was held in Thai (local language).

Meetings procedure

- Project description of the project and environmental impacts (10 min)
- Questions and Answers session (5 min)
- General feedback (5 min)

Meeting documents and protocols

On completion of the various meetings, the documentation in following subjects was collected and attested by the signatures of the stakeholders that were present:

1. Non-technical description of the project
2. Environmental impacts of the project
3. Contribution to sustainable development

Compilation of comments received:

The overall response to the project, from all invited stakeholders, was encouraging and positive to local environment and social-economic conditions by cleaning the wastewater in a more efficient way, avoiding odour emissions from the lagoons and creating new jobs.

In all, no adverse reaction/ comments/ clarifications have been sought/ received during the Stakeholder Consultation process. The project participants did not recognize any need to make changes to the project design or monitoring plan.

7 Schedule:

Chronological plan of the project activity is as follows:

Date	Event	Comment
1 st March 1994	The starch factory is firstly operated	Operation permit for starch factory (Somdej Flour Mill Co. Ltd.)
July 2004	The technological and financial proposal is submitted by Technology provider.	Source: Technical and commercial proposal by Papop Co., Ltd.
28 th July 2004	Letter by Papop Co., Ltd. outlining the importance of carbon credit revenues in order to	Source: Letter by Papop Co., Ltd.

	improve the financial feasibility of the project	
9 th August 2004	Internal board meeting to discuss the feasibility of the biogas project, highlighting the need for carbon credit revenues as a crucial factor for the viability of the project	Source: Minutes of board meeting of Somdej Flour Mill Co., Ltd. Somdej Flour Mill Co., Ltd. decided to pursue carbon finance through intermediation of Papop Co., Ltd.
7 th September 2004	SD Biosupply Co., Ltd. is registered as company.	Source: Company affidavit (SD Biosupply Co., Ltd.)
6 th October 2004	Biogas construction contract signed. (Project investment decision date)	Source: Design and construction contract between SD Biosupply Co., Ltd. and Papop Co., Ltd.
10 th June 2005	SD Biosupply Co., Ltd. starts operation.	Source: Operation permit permits for SD Biosupply Co., Ltd.
18 th August 2005	The first date of wastewater entered to UASB reactor referred to commissioning report.	Source: The confirmation commissioning report sent from Papop Co., Ltd.
16 th September 2005	The first date of emission reduction starts. (Project starting date)	Source: The first log sheet shows the biogas production and utilization in boiler and flare.
12 th May 2006	Papop Co., Ltd. signed the Confidentiality Agreement with South Pole Asset Management and Papop Co., Ltd.	Start of discussions between South Pole Asset Management and Papop Co., Ltd. The agreement covers a portfolio of emission reduction projects, including SD Biosupply Co., Ltd.
10 th May 2007	Appointment of Authorization by Papop Co., Ltd. for South Pole Carbon Asset Management to represent Papop projects for DNA approval, validation and CDM registration, among others.	Source; Appointment of Authorization Letter between Papop Co., Ltd. and South Pole Carbon Asset Management
20 th February 2008	ERPA signed between SD Biosupply Co., Ltd. and South Pole Carbon Asset Management.	Emission Reduction Purchase Agreement signed after long negotiation period.
12 th March 2008	Signature of VCS Validation contract between South Pole Carbon Asset Management and DOE.	
22 nd July 2008	Stakeholder consultation	
8 th January 2009	Frame work agreement in relation to the Carbon Management Agreement	Signed agreement between Somdej Flour Mill Co. Ltd. and South Pole Carbon Asset Management

Frequency of monitoring and reporting:

It is planned that the monitoring period and reporting of emission reductions from the project activity will be done. The monitoring frequency of each parameter will vary depending on their types and the requirements of the applied methodology. This is elaborated in section 3.3 of this VCS PD. In addition, the acquainted data shall be kept by the project proponents for a minimum of 2 years after the crediting period.

Generally speaking, calibration of equipments will be done on at a minimum of once in three year basis.

Project period:

The crediting period of the project is of 10 years (renewable), 28th March 2006 – 27th March 2016).

After the initial crediting period of ten years, subsequent renewals of the crediting time might be considered according to the status of the project activity and baseline revision at that time.

8 Ownership:

8.1 Proof of Title:

Documents (i.e. land deed and company affidavit) assessing the ownership of the wastewater treatment plant from SD Biosupply Co Ltd. provided to the DOE during the validation.

8.2 Projects that reduce GHG emissions from activities that participate in an emissions trading program (if applicable):

Not applicable in Thailand.

Annex I: Meeting document

Invitation to comment the “SD Biosupply Wastewater Treatment and Biogas Utilization Project”

Date: Friday, July 7, 2008

This document presents briefly an emission reduction project submitted for validation under Voluntary Carbon Standard. We would like to invite you to provide a comment or bring your support to this project. Comments can be sent by email to info@southpolecarbon.com within one week after the date above.

Project name: SD Biosupply Wastewater Treatment and Biogas Utilization Project

Host country: Thailand

Location: 99 Somdej-Khuchinarai, Kambong, Huai Phueng District, Kalasin

Scope: Renewable energy projects

Standard: Voluntary Carbon Standard

Methodologies: AMS III.H “Methane Recovery in Wastewater Treatment” (Version 9) and AMS I.C “Thermal energy for the user with or without electricity” (Version 12)

tCO₂e/a: 24,000

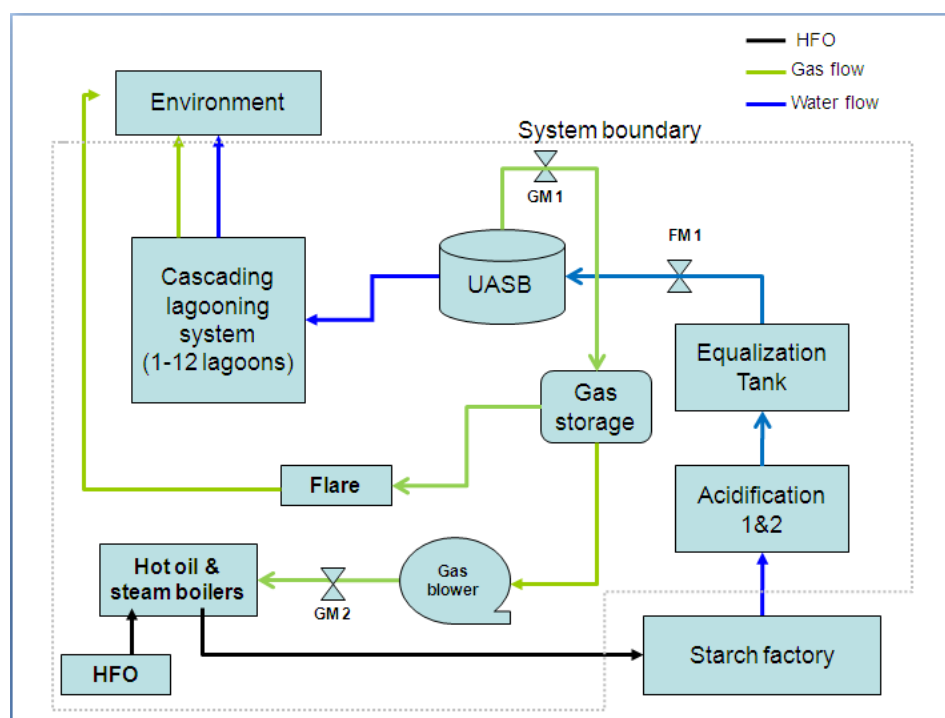
Operation starting date: 28 March 2006

Short description:

A. The proposed project is implemented at SD Starch (2000) Co., Ltd. a starch plant has a total production capacity of 300 tonnes of native starch per day, generating an average of 2,000 m³ of wastewater per production day.

The proposed project activity entails the installation of an anaerobic wastewater treatment facility, based on Upflow Anaerobic Sludge Blanket (UASB) biogas reactor technology, at the existing starch manufacturing plant, replacing the open anaerobic lagoon based system (composed of 12 cascading lagoons with a retention time of more than one year). The biogas reactor system will generate and recover biogas for energy generation purposes, avoiding methane emissions to the atmosphere. The captured methane will be used as fuel in existing heat generating devices in the starch plant replacing heavy fuel oil, which will lead to further CO₂ reductions by replacing a fossil fuel. Any surplus methane is flared in an open flare.

A diagram summarising the technology installed is provided below.



Environmental impacts:

The quality of the treated water, which is subject to effluent standards regulated by the environmental authorities, will improve substantially due to higher efficiency and improved process control of the biogas reactor as compared to open lagoons. In fact, the biogas reactor system allows the starch factory to reuse the treated effluent in the cassava production process, contributing to water conservation. Further, the project will avoid odour emissions as compared to an anaerobic lagoon, which contributes significantly to an improved life quality around the project site.

Contribution to sustainable development:

The project activity does also contribute to technology transfer from Thailand and efficiency improvement of the agro-industry, which will benefit a rural and underdeveloped region of the country. New jobs are created during the construction and operation of the biogas reactor system and regional economic development is fostered through contracts to local firms related to construction, operation and maintenance of the plant.

Annex II: Stakeholder Consultation Participants

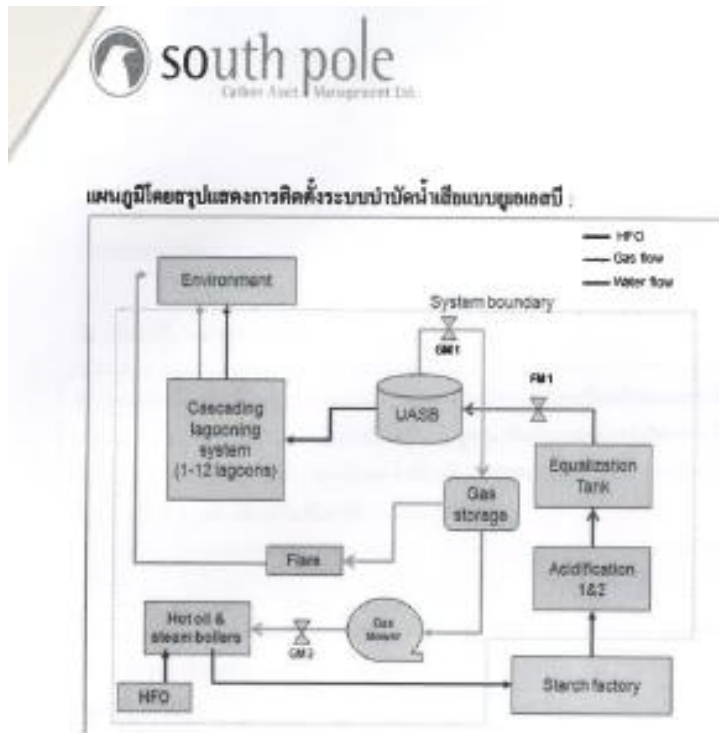


Figure 1: Local residents



Figure 2: Local government

Annex III: Meeting document sample with stakeholder signatures



ผลกระทบต่องานด้านอื่น :

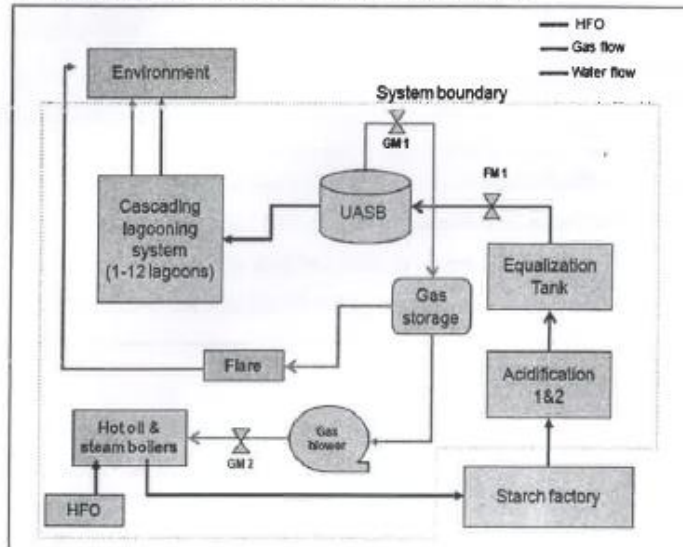
คุณภาพน้ำที่ผ่านการบำบัดแล้วจะผ่านมาตรฐานคุณภาพน้ำทิ้งตามที่หน่วยงานสิ่งแวดล้อมกำหนด โดยเมื่อเปรียบเทียบกับระบบบำบัดน้ำเสียแบบยูเอสบีกับระบบบำบัดน้ำเสียแบบข่อเปิด (แบบเก่า) พบว่าระบบยูเอสบีจะมีประสิทธิภาพในการบำบัดและควบคุมการปล่อยก๊าซชีวภาพได้ดีกว่า นอกจากนี้มีน้ำเสียที่ผ่านการบำบัดด้วยระบบยูเอสบียังสามารถนำกลับมาใช้ใหม่ในระบบการผลิตแอมโมเนียได้อีกด้วยนำไปสู่การอนุรักษ์การใช้น้ำ และระบบบำบัดน้ำเสียแบบยูเอสบียังสามารถลดปัญหากลิ่นรบกวนซึ่งเป็นการพัฒนาคุณภาพชีวิตของชุมชนโดยรอบ โครงการได้อีกด้วย

การพัฒนาอย่างยั่งยืน :

โครงการนี้ได้มีการเปลี่ยนเทคโนโลยีเพื่อปรับปรุงประสิทธิภาพการทำงานของระบบบำบัดน้ำเสียของอุตสาหกรรม การเกษตร อันจะเกิดประโยชน์แก่ชุมชนชนบทและภูมิภาคที่ขาดการพัฒนาของประเทศไทย นอกจากนี้จะก่อให้เกิดการสร้างอาชีพในช่วงการก่อสร้างและการดำเนินโครงการระบบบำบัดน้ำเสีย ซึ่งยังคงต่อการพัฒนาเศรษฐกิจในภูมิภาคโดยผ่านทางกิจกรรมการก่อสร้าง การดำเนินการและการบำรุงรักษาของโครงการดังกล่าว

ลงชื่อ
(นายวิชาญ จันทร์ดี)
ผู้จัดการ

แผนภูมิโดยสรุปแสดงการคิดตั้งระบบบำบัดน้ำเสียแบบยูเอเอสบี :



ผลกระทบต่อสิ่งแวดล้อม :

คุณภาพน้ำที่ผ่านการบำบัดแล้วจะผ่านมาตรฐานคุณภาพน้ำทิ้งตามที่หน่วยงานสิ่งแวดล้อมกำหนด โดยเมื่อเปรียบเทียบกับระบบบำบัดน้ำเสียแบบยูเอเอสบีกับระบบบำบัดน้ำเสียแบบบ่อเปิด (แบบเก่า) พบว่าระบบยูเอเอสบีจะมีประสิทธิภาพในการบำบัดและควบคุมการปล่อยก๊าซชีวภาพได้ดีกว่า นอกจากนี้ น้ำเสียที่ผ่านการบำบัดด้วยระบบยูเอเอสบียังสามารถนำกลับมาใช้ในกระบวนการผลิตแป้งมันได้อีกด้วยนำไปสู่การอนุรักษ์การใช้น้ำ และระบบบำบัดน้ำเสียแบบยูเอเอสบียังสามารถลดปัญหากลิ่นรบกวนซึ่งเป็นการพัฒนาคุณภาพชีวิตของชุมชนโดยรอบโครงการ ได้อีกด้วย

การพัฒนาอย่างยั่งยืน :

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ลงชื่อ

(Signature)

(นายคำตัน ม่วงเพชร)

นายกองค์การบริหารส่วนตำบลลำห้วยขมิ้น

Annex IV: Efficiency of boiler pre and post project activity

The project proponent has used a conservative approach to estimate the emission reductions. Following are the key indicators to the conservative approach:

- The project activity shall result in more methane (biogas) generation as compared to the ex ante estimations. This is because the efficiency of the anaerobic system (UASB) is much more than the baseline system.⁵⁰
- The biogas usage as fuel poses many problems as the flow of fuel is dependent on biogas generation rather than human preference. This makes it necessary for project proponent to co fire the fuel oil with biogas to sustain the boiler operation. This means that efficiency of burning methane is lower than the fuel oil in the baseline scenario.
- For estimation of emission reduction the following approach is used.

The lowest annual average value of fuel oil (l/kg) used per kg of starch is taken as baseline consumption value of fuel oil ($q_{ff, starch}$).

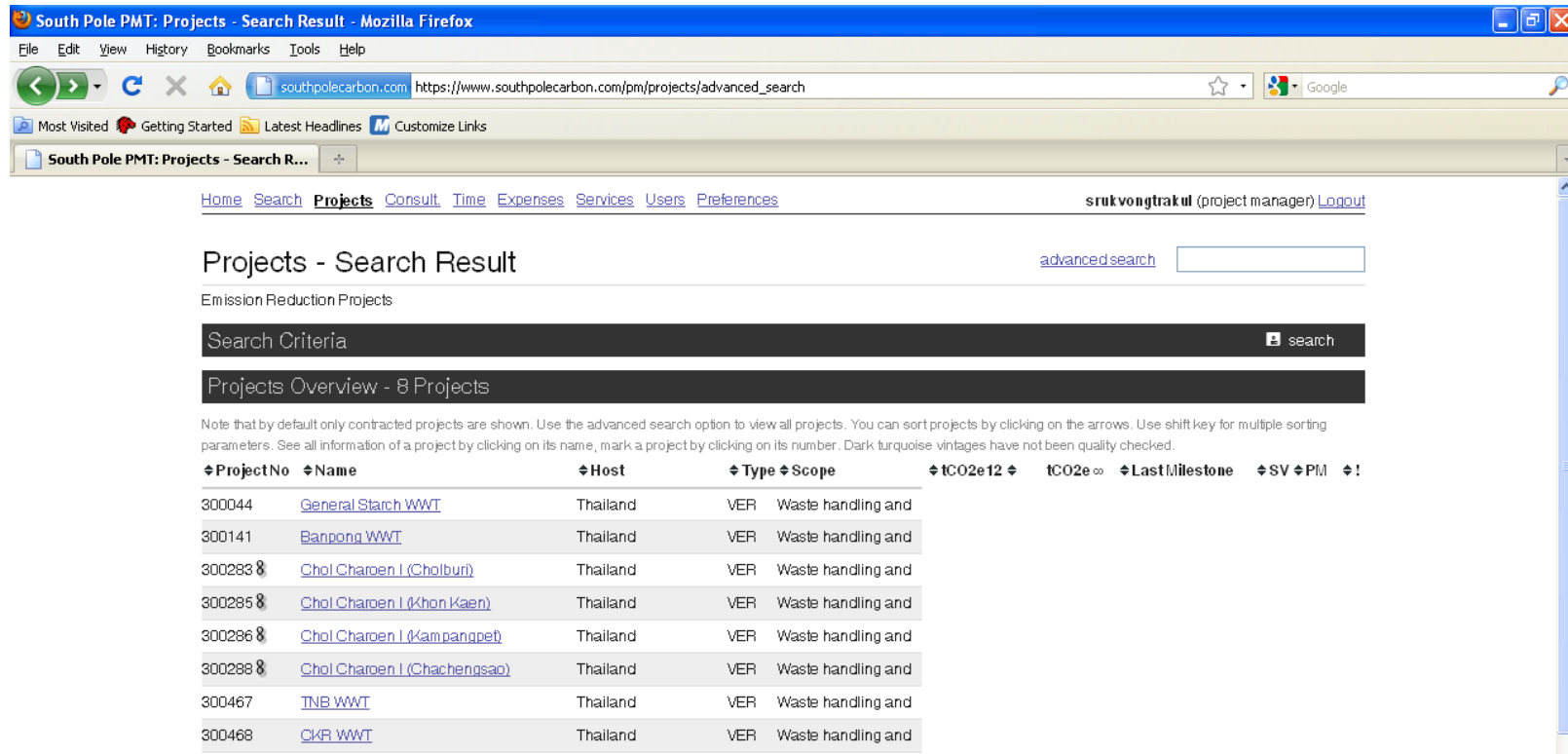
For each year, the starch production and fuel oil consumption is monitored. From the value of total starch generation the amount of fuel oil that would have been required in baseline is estimated.

The quantity of fuel oil consumed in same year is subtracted from this value giving the conservative value of fuel oil that is replaced by biogas.

The monitoring for each year shall clearly demonstrate that energy consumption per unit of starch generated is always higher than the assumed baseline case.

⁵⁰ Can be established from the monitored results for the post project implementation

Annex V: VER projects from South Pole's Project Management Tool



South Pole PMT: Projects - Search Result - Mozilla Firefox

File Edit View History Bookmarks Tools Help

southpolecarbon.com https://www.southpolecarbon.com/pm/projects/advanced_search

Most Visited Getting Started Latest Headlines Customize Links

South Pole PMT: Projects - Search R...

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srukvongtrakul (project manager) Logout

Projects - Search Result

[advanced search](#)

Emission Reduction Projects

Search Criteria

Projects Overview - 8 Projects

Note that by default only contracted projects are shown. Use the advanced search option to view all projects. You can sort projects by clicking on the arrows. Use shift key for multiple sorting parameters. See all information of a project by clicking on its name, mark a project by clicking on its number. Dark turquoise vintages have not been quality checked.

ProjectNo	Name	Host	Type	Scope	tCO2e12	tCO2e	Last Milestone	SV	PM	!
300044	General Starch WWT	Thailand	VER	Waste handling and						
300141	Banpong WWT	Thailand	VER	Waste handling and						
300283	Chai Charoen I (Cholburi)	Thailand	VER	Waste handling and						
300285	Chai Charoen I (Khon Kaen)	Thailand	VER	Waste handling and						
300286	Chai Charoen I (Kampanget)	Thailand	VER	Waste handling and						
300288	Chai Charoen I (Chachengsao)	Thailand	VER	Waste handling and						
300467	TNB WWT	Thailand	VER	Waste handling and						
300468	CKR WWT	Thailand	VER	Waste handling and						