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

CONTENTS

Annexes

Revision history of this document

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

SECTION A. General description of small-scale project activity

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

Biogas Plant at United Plantations Berhad, ULU BASIR Palm Oil Mill

Version No.: Version 4
Date: 27/09/10

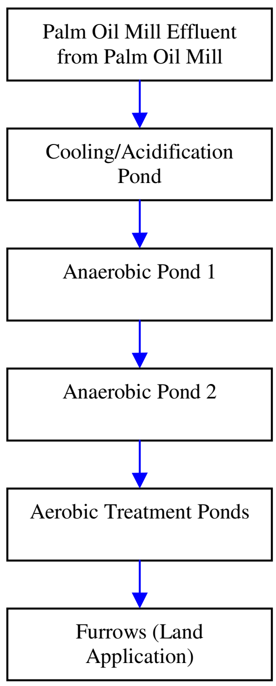
A.2. Description of the small-scale project activity:

This project is implemented by United Plantations Berhad at its ULU BASIR Palm Oil Mill (referred to as ULU BASIR POM). United Plantations Berhad is a public listed plantation company, listed on the Bursa Malaysia (Kuala Lumpur Stock Exchange Main Board).

United Plantations Berhad is member of the Roundtable for Sustainable Palm Oil (RSPO) and has obtained RSPO certification for the ULU BASIR palm oil mill and the ULU BASIR estates which supply fresh fruit bunches (FFB) to the mill.

United Plantations Berhad is the first palm oil plantations group in the world to successfully obtain the RSPO certification on 26th August, 2008. The certification is valid for 5 years with annual successful stakeholders' consultation and audit. Stakeholders' consultation has been carried out and the annual audit will be carried out in August, 2009.

At present, the POME (Palm Oil Mill Effluent) from ULU BASIR POM is treated by means of the conventional open pond system comprising a series of cooling/acidification, anaerobic and aerobic lagoons before being discharged to land application via shallow furrows (~ 0.5m depth). Biogas produced from the open anaerobic lagoons, constituting mainly of methane (CH_4) and carbon dioxide (CO_2), and traces of hydrogen sulfide (H_2S) is emitted to the atmosphere. The palm oil mill's electricity demand is supplied by the grid (TNB), a diesel generator and a biomass boiler.



The proposed project activity involves the installation of a closed anaerobic digester system to replace the existing open anaerobic lagoons for the treatment of POME. Biogas generated in the process will be captured and utilized in the existing biomass boiler as supplementary fuel to biomass waste. Methane will be flared in a closed flare during the period of time where it can not be utilized in the biomass boiler (i.e. whenever the boiler is not in operation).

The effluent from the anaerobic digester system will be routed to the aerobic lagoons and finally discharged to land application via shallow furrows (~ 0.5m depth).

Capture and destruction of methane from the biodegradation of organic content in POME that would have otherwise been emitted to the atmosphere contributes to significant greenhouse gas (GHG) emission reductions.

Figure 1 Current layout of POME treatment facility

Sustainable development
The project activity contributes in the following ways to sustainable development:

Environmental sustainability

1. Reduce local air pollution by capturing biogas (which contain CH_4, CO_2 and H_2S) emission from anaerobic treatment of the POME in open ponds;
2. Controlled treatment of waste water

Economic sustainability

1. Utilization of biogas as a renewable energy source;
2. Displacement of biomass fuel with biogas will promote displacement of fossil fuels elsewhere;

Social sustainability

1. Improve the working environment for mill workers as the bad odour from the open lagoon treatment system is avoided;
2. Create new jobs for local population, short term (during plant construction phase) and long term (for plant operation and maintenance); and
   improve the technical skills of staff in the operations and maintenance of the new anaerobic digester system.

A.3. Project participants:

Name of Party involved (*) ((host) indicates a host Party)	Private and/or public entity(ies) project participants (*) (as applicable)	Kindly indicate if the Party involved wishes to be considered as project participant (Yes/No)
Malaysia (host)	Private entity: United Plantations Berhad	No
Denmark	Public entity: Ministry of Climate and Energy	No
(*) In accordance with the CDM modalities and procedures, at the time of making the CDM-PDD public at the stage of validation, a Party involved may or may not have provided its approval. At the time of requesting registration, the approval by the Party(ies) involved is required.		

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

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

The project activity is located at United Plantations Berhad, ULU BASIR Palm Oil Mill near Ladang Ulu Basir, Ulu Bernam, Perak, Malaysia.

A.4.1.1. Host Party(ies):

Malaysia

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

Perak State

A.4.1.3. City/Town/Community etc:

Ladang Ulu Basir, 36500 Ulu Bernam

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

ULU BASIR Palm Oil Mill, located in Ladang Ulu Basir, Bernam, in the State of Perak, Malaysia is the proposed location of the project activity. The location of the mill and the source generating the wastewater is given by the GPS Coordinates, below:
N 3 43.408, E 101 15.383

The location of the biogas plant is given by the GPS coordinates below:
N 3 43.583, E 101 15.625

Figure 2 Location of Project Activity

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

The project activity is a methane recovery and utilisation project, which falls under Sectoral Scope 13: Waste handling and disposal. It is a type III.H *"Methane Recovery in waste water treatment"* according to the "*Simplified Modalities and Procedures for Small-Scale CDM Project Activities"*.

Technology to be employed for the project activity.

The Continuous-flow Stirred Tank Reactor (CSTR) system adopted provides approximately 18 days of hydraulic retention time for the mesophilic anaerobic digestion of POME. The system will be equipped with dual-function complete-mixed mechanism which would facilitate long-term continuous operation without any interruption for removal of any accumulated settled sludge.

Biogas generated will be captured in the enclosed digester tanks with both fixed and floating roof designs. The floating roof tank will provide sufficient buffer capacity for the extraction of biogas generated and captured for use in energy (steam) generation equipment. Methane will be flared in a closed flare during the period of time where it can not be utilized in the biomass boiler (i.e. whenever the boiler is not in operation).

The effluent from the anaerobic digester system will be discharged to the aerobic ponds and subsequently to the plantation for land application via shallow furrows (~0.5m depth).

The existing biomass boiler will be retrofitted with a biogas burner for combustion of biogas.

Anaerobic Digester Technology employed in the project activity

An efficient closed tank anaerobic digestion technology, based on the continuous flow stirred tank reactor system (CSTR) with sludge return design, will be implemented for the palm oil mill effluent (POME) treatment at ULU BASIR Palm Oil Mill to replace the existing deep open lagoon system for anaerobic digestion.

The CSTR system is equipped with a dual-function complete mixing mechanism, comprising pump-aided circulation and gas-lifting mixing, to maximize the anaerobic digestion efficiency. The complete-mixed system will facilitate long-term continuous operations without needs of any interruptions for sludge removal. The anaerobic digestion will be operating under mesophilic conditions with temperature ranging from 35-40 °C. The digester system for the proposed project activity is designed with a hydraulic retention time of ~18 days, more than the optimum retention time of 15 days which is commonly recommended based on theoretical requirement. The CSTR anaerobic digestion design has been proven to be most efficient and appropriate for POME treatment, considering the unique characteristics of POME in terms of its very high levels of BOD and COD, in both dissolved and semi-solid forms, concurrent with high Suspended Solids and emulsified oil.

The biogas generated will be captured in the enclosed anaerobic digester tanks. Tanks equipped with floating roofs allow for a significant volume of buffer storage capacity for biogas. The provision of the buffer storage is essential for the efficient operation of the boiler using biogas for steam generation.

Treated effluent from the anaerobic digester tanks will be discharged to existing aerobic open lagoons for facultative/aerobic treatment after which the effluent will be pumped to the plantation for land application.

A flow diagram of the proposed project activity is shown below. The design and construction of the anaerobic digester plant will comply with national Technical Specifications and Standards, basically referencing to the British Standard Specifications and Malaysian National Standard and Code and Practice. Precautions are specially taken to ensure that the anaerobic digester tanks and biogas pipeline will be free from any leakages.

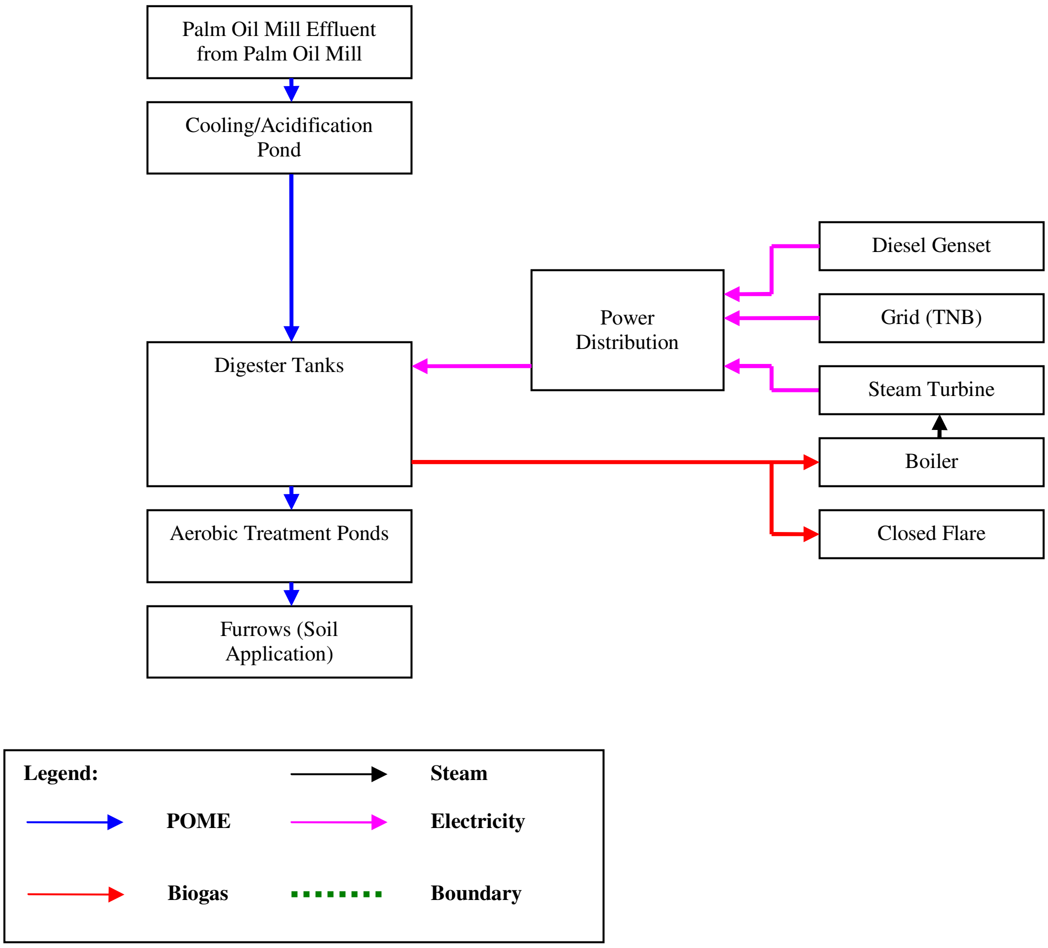


Figure 3 Layout of POME treatment facility after implementation of Project Activity

Utilization and flaring of biogas

The biogas captured will be supplied and utilized for steam generation using the existing biomass waste fired boiler at the mill. The boiler will be fitted with a biogas burner with automatic control to allow for biogas-firing. The biogas will displace partially some biomass waste. Methane will be flared in a closed flare during the period of time where it can not be utilized in the biomass boiler (i.e. whenever the boiler is not in operation).

A.4.3 Estimated amount of emission reductions over the chosen crediting period:	
Year	**Annual estimation of emission reductions in tons of CO2e**
2010 (15/10–31/12)	4,154
2011	19,941
2012	20,531
2013	21,120
2014	21,120
2015	21,592
2016	22,064
2017	22,536
2018	23,007
2019	23,479
2020 (1/1-14/10)	15,787
Total Estimated Reductions (tons of CO2e)	**215,335**
Total number of Crediting Years	10
Annual average over the crediting period of estimated reductions (tons of CO2e)	21,534

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

The project has not received and is not seeking public funding.

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

As highlighted in Appendix C of the Simplified Modalities and Procedures for Small-Scale CDM project activities, a proposed small-scale project activity shall be deemed to be a debundled component of a large project activity if there is a registered small-scale CDM project activity or an application to register another small-scale CDM project activity:

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

On the basis of the above, the project is not a debundled component of a larger project

SECTION B. Application of a baseline and monitoring methodology

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

This project activity uses the approved baseline and monitoring methodology AMS III.H version 13 "Methane Recovery in Wastewater Treatment"

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

The methodology, AMS III.H version 13, is applicable to the project activity through the following criteria:

AMS III H Version 13	Project Activity Applicability
Under this methodology anaerobic lagoons are considered ponds deeper than 2 meters, without aeration, ambient temperature above 15°C, at least during part of the year, on a monthly average basis, and with a volumetric loading rate of Chemical Oxygen Demand above 0.1 kg COD.m-3.day-1. The minimum interval between two consecutives sludge removal events shall be 30 days.	Ponds are deeper than 2 meters and without aeration. The ambient temperature is above 15°C[1] throughout the year, on a monthly average basis. The volumetric loading rate of Chemical Oxygen Demand is above 0.1 kg COD.m-3.day-1[2]. The minimum interval between two consecutive sludge removal events is 30 days.
Paragraph 1, option (iv): "This methodology comprises measures that recover biogas from biogenic organic matter in wastewaters by means of one, or a combination, of the following options: (iv) Introduction of biogas recovery and combustion to an existing anaerobic wastewater treatment system such as anaerobic reactor, lagoon, septic tank or an on site industrial plant;"	The project activity comprises measures that recover biogas from biogenic organic matter in wastewater by means of introducing biogas recovery and combustion to an existing anaerobic wastewater treatment system. The project activity will recover biogas by introducing digester tanks to an existing lagoon wastewater treatment system. Recovered biogas will be combusted in a combined biomass and biogas boiler. Methane will be flared in a closed flare during the period of time where it can not be utilized in the biomass boiler (i.e. whenever the boiler is not in operation).
Paragraph 2 (a): "The recovered biogas from the above measures may also be utilised for the following applications instead of combustion/flaring: (a) Thermal or electrical energy generation	The biogas recovered in the project activity will be utilized for thermal energy generation. Methane will be flared in a closed flare during the period of time where it can not be utilized in the biomass boiler (i.e. whenever the boiler is not in operation).

[1] http://www.climatetemp.info/malaysia/

[2] As demonstrated by the measurement campaign in Annex 3.

directly;”	
Paragraph 12: “Measures are limited to those that result in aggregate emission reductions of less than or equal to 60 kt CO2 equivalent annually from all Type III components of the project activity.”	The estimated annual aggregate emission reductions from all Type III components of the project activity are less than or equal to 60 kt CO2 equivalent throughout the crediting period as per section A.4.3. Since the emission reductions are less than 60k t CO2 equivalent, the project is eligible for using an approved type III small scale baseline methodology.

As the baseline scenario is to treat biogenic organic matter in waste water using anaerobic lagoons and the project activity is to introduce biogas recovery and combustion leading to annual emission reductions less than or equal to 60 kt CO2 equivalent throughout the crediting period, AMS III H Version 13 option (iv) is applied to the project activity.

B.3. Description of the project boundary:

According to AMS.III.H./Version 13, 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.
A representation of the project boundary can be seen be seen in Figure 4 below.

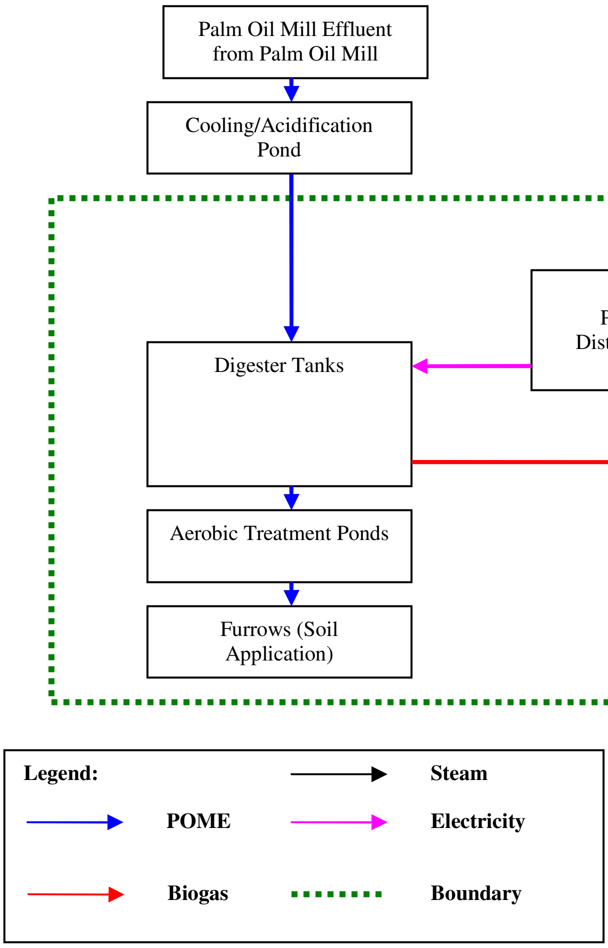


Figure 4 Boundary of Project Activity

B.4. Description of baseline and its development:

The baseline scenario of this project activity is the continuation of the existing open pond-based wastewater treatment system without methane capture and combustion. The mill is currently treating the raw POME (palm oil mill effluent) through a series of ponds which include a Cooling/Acidification Pond, two deep Anaerobic Ponds and two Aerobic Ponds before discharging treated POME for soil application.

During anaerobic treatment, organic materials in POME will be digested and methane gas will be released to the atmosphere.

The baseline is referenced in AMS-III.H version 13 paragraph 1 (iv): "Introduction of biogas recovery and combustion to an existing anaerobic wastewater treatment system such as an anaerobic reactor, lagoon, septic tank or an on site industrial plant".

Baseline data and assumptions used to determine the baseline emissions include the following:

Parameter	Description	Value	Unit	Source
Anaerobic lagoon depth	Anaerobic lagoon depth	3	m	Project proponent
$\mathbf{COD_{ww,untreated,y}}$	COD concentration in POME entering anaerobic treatment lagoons	65.5	kg/m^3	Measurement campaign (summarized in Annex 3)
$\mathbf{COD_{ww,treated,y}}$	COD concentration in POME entering aerobic treatment lagoons	3.9	kg/m^3	Measurement campaign (summarized in Annex 3)
Amount of fresh fruit bunches	Yearly amount of fresh fruit bunches to be processed by the palm oil mill	170,000	tons	Forecast based on current production and replanting scheme (summarized in Annex 3). Value shown is for year 1
POME generation factor	Average volume of POME generated per ton of Fresh Fruit Bunches processed	0.75	m^3/ton	Measurement campaign (summarized in Annex 3)
$EC_{BL,y}$	Baseline yearly electricity consumption	0	kWh	Project Proponent
$MCF_{ww,treatment}$	Methane correction factor for anaerobic wastewater treatment	0.8	-	AMS III H Version 13
$B_{o,ww}$	Methane producing capacity of wastewater	0.21	-	AMS III H Version 13
GWP_CH4	Global Warming Potential of Methane	21	-	AMS III H Version 13
$MCF_{s,treatment,BL,j}$	Baseline methane correction factor for soil application of	0	-	AMS III H Version 13

	sludge			
$MCF_{ww,BL,discharge}$	Baseline methane correction factor for discharge of wastewater to soil application	0	-	AMS III H Version 13

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

Early consideration of CDM

Prior to the decision to implement the project, the project developer considered CDM necessary for establishing the project. The main milestones showing that CDM is an integral part of the decision leading to implement the project are shown below:

Date	Event
27/2/2009	Appointment of Project Manager and CDM coordinator
14/5/2009	Expression of interest from CDM Partner
16/5/2009	Board Meeting Approval
6/7/2009	Award of first contract related to the construction of the project (foundation works) and start of construction.
31/7/2009	Submission of PDD for DNA approval
20/8/2009	Letter of intent with CDM buyer
19/11/2009	Conditional Letter of Approval from Malaysian DNA

Demonstration of additionality

Additionality is demonstrated in accordance with “tool for the demonstration and assessment of additionality version 5.2”.

Step 1: Identification of alternatives to the project activity consistent with current laws and regulations

Sub-step 1a: Alternatives to the project activity
Two realistic and credible alternatives have been identified[2]. These are:

1. Closed anaerobic digester (without being registered as a CDM project activity)
2. Open anaerobic digester (continuation of the current situation)

Sub-step 1b: Consistency with mandatory laws and regulations
Both alternatives, alternatives 1 & 2, were identified to be realistic and credible alternative scenario(s) to the project activity that are in compliance with mandatory legislation and regulations in Malaysia.

Step 2: Investment analysis

Step 2 is not applicable as Step 3 (Barrier Analysis) is chosen to demonstrate additionality as shown below.

Step 3: Barrier analysis

Step 3 is chosen to determine that the proposed project activity is facing barriers that:

(a) Prevent the implementation of the proposed project activity; and
(b) Do not prevent the continuation of the current situation.

Sub-step 3a: Identification of barriers that would prevent the implementation of the proposed CDM project activity

One realistic and credible barrier has been identified which is preventing the project from implementation. This barrier is:

1. Technological barriers

Technological barriers facing the project activity are discussed below.

Technological Barriers

The project activity is facing technological barriers due to the following:

- Lack of infrastructure for implementation of the technology: Biogas can not be used due to the lack of consumers who have fossil fuel to be displaced by the biogas and the lack of a gas transmission and distribution network;
- Greater risk of technological failure: the process/technology failure risk in the local circumstances is significantly greater than for other technologies that provide services or outputs comparable to those of the proposed CDM project activity;
- Additional and more stringent safety procedures shall be implemented due to the greater risk of handling biogas;

Lack of infrastructure for implementation of the technology
Due to the abundant and excess biomass energy sources available in all palm oil mills, the capture of biogas from POME treatment as a fuel has rarely been taken into serious consideration. The exceptions are for those palm oil mills located within a palm oil processing industrial complex. Transportability and off-site utilization of biogas is limited as it is not practical to liquidify methane, the major component in biogas, by conventional and economical means[3].

In the proposed project activity, biogas can not be used to displace fossil fuels at the mill site because the mill is already self-sufficient with energy from biomass waste. The project activity is not located within a palm oil processing industrial complex and there is no biogas transmission and distribution network in place to distribute the biogas to other users.

This demonstrates that the proposed project activity is prevented by a lack of infrastructure for implementation as there is excess energy from biomass waste and a lack of infrastructure for its distribution.

Greater risk of technological failure

[3] POME Biogas Capture, Upgrading, and Utilisation, S. L. Tong and A. Bakar Jaafar (Page 332)

The proposed project activity is subject to greater risk of technological failure due to the lack of reference plants and due to the introduction of biogas to site.

Based on the typical biogas composition, there are at least two conspicuous properties that need to be enhanced before commercial use of the biogas can be realized for use in boilers. A potential drawback to the use of biogas is the presence of hydrogen sulphide. Aside from intensifying research efforts toward high production yield of biogas, work must also be carried out in scrubbing the gas of corrosive components such as hydrogen sulphide[4]. This demonstrates that the project activity is facing greater risk of technological failure as the project is using biogas in existing boilers.

The introduction of an explosive gas to the site is accompanied by greater risk of technological failure due to the possibility of an explosion[5,6]. This demonstrates that the project activity is facing greater risk of technological failure as an explosion could lead to damages to equipment.

Greater risk of handling biogas

A potential risk associated with the introduction of biogas systems is related to safety of personnel in the operation of the system. Methane is a highly explosive gas and therefore strict safety procedures and measures are required in order to prevent any accidents from occurring. Methane is not only an explosive gas but can also through unintended inhalation cause unconsciousness for humans. Methane is odorless and employees who work in confined spaces where methane may be leaking are at greater risk of being exposed to unhealthy working conditions potentially leading to unconsciousness and accidents[7]. Appropriate measures and procedures must be installed in an effort to prevent such situations from occurring. Unfortunately, such incidents can never be fully mitigated. This demonstrates that the introduction of biogas to the site increases the risk of incidents.

This demonstrates that the project activity faces technological barriers as a less technologically advanced alternative to the project activity exists which involves lower risks due to the reasons stated above and is already implemented at the site, and would be the most likely baseline scenario.

Sub-step 3b: Show that the identified barriers would not prevent the implementation of at least one of the alternatives (except the proposed project activity):

In the following it is demonstrated that the identified barriers would not prevent the implementation of alternative 2 (continuation of the current situation).

Lack of infrastructure for implementation of the technology

In the following paragraph, it is demonstrated that alternative 2 (continuation of the current situation) is not facing a barrier in relation to lack of infrastructure for implementation of the technology.

In alternative 2, there is not a lack of infrastructure for implementation and distribution of biogas since no biogas is produced.

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4 Standards & Quality News SIRIM 3/2006 Vol.13 No. 3 (Page 12)

5 http://www.thehindu.com/2009/08/27/stories/2009082761930100.htm

6 http://www.nst.com.my/Current_News/NST/articles/31kill/Article/index_html

7 http://anaerobic-digestion-news.blogspot.com/2008/12/four-killed-by-biogas-in-digester-tank.html

There is not a demand for energy from biomass waste as the demand for energy is already covered by the solid biomass waste (i.e. palm kernel shells) produced by the mill.

The solid biomass waste is produced at the mill where it is also utilized for energy generation. This shows that there is not a lack of infrastructure for the implementation of using solid biomass waste for fuel as there is no need for transportation of solid biomass waste.

This demonstrates that alternative 2 is not facing any barriers in relation to lack of infrastructure for implementation of the technology as the demand for energy from biomass waste is already covered and there is not a need for infrastructure for implementation of the technology.

Greater risk of technological failure

In the following paragraph, it is demonstrated that alternative 2 (continuation of the current situation) is not facing a barrier in relation to greater risk of technological failure.

Alternative 2 (continuation of the current situation) is not facing greater risk of technological failure due to lack of reference plants and standards since the open lagoon technology is the prevailing wastewater treatment technology at palm oil mills for the treatment of POME[8].

In alternative 2, there is not a greater risk of technological failure since no biogas is utilized in the boiler.

Lagoons use simple design and are simple to operate and maintain and generally require only part-time staff[9].

This demonstrates that alternative 2 is not facing any barriers in relation to greater risk of technological failure as alternative 2 is the prevailing practice and it is simple to design, operate and maintain.

Greater risk of handling biogas

In the following paragraph, it is demonstrated that alternative 2 (continuation of the current situation) is not facing a barrier in relation to greater risk of handling biogas.

Lagoons and biomass waste will be operated in both alternative 2 (continuation of the current situation) and the proposed project and therefore the difference between the two scenarios will be the handling of biogas. Since biogas is not handled in alternative 2 there are no additional safety risks related to the handling of gases such as exposure to gas leakages, explosive atmospheres, confined spaces, unintended inhalation and related gas safety risks.

This demonstrates that alternative 2 is not facing any barriers in relation to greater risk of handling biogas as alternative 2 is not handling any biogas.

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[8] Ministry of Energy, Water and Communications, PTM, DANIDA (December 2004). Study on Clean Development Mechanism Potential in the Waste Sectors in Malaysia (Pages 48)

[9] http://www.lagoonsonline.com/desopreg.htm (Pages 4-5)

In conclusion, Step 3 has identified barriers preventing the proposed project activity (alternative 1) and shown that the same barriers do no prevent the current situation (alternative 2).

Sub-step 3a identified three barriers preventing alternative 1 from occurring, including lack of infrastructure for implementation of the technology, greater risk of technological failure and greater risk of handling biogas. These barriers were demonstrated to be due to the lack of demand for energy and a lack of infrastructure for distribution of biogas and greater risks to personnel and equipment related to the handling of biogas.

In sub-step 3b, it was demonstrated that the three barriers do not to prevent the implementation of alternative 2 (continuation of the current situation) as alternative 2 is the prevailing practice, no biogas is being handled and it is simple to design, operate and maintain.

Step 4: Common practice analysis

Sub-step 4a: Analysis of other activities similar to the proposed project activity:

In the following it is demonstrated that prevailing practice or existing regulatory or policy requirements would have led to implementation of a technology with higher emissions.

Malaysia has about 434 palm oil mills[10]. The prevailing practice for these mills is to treat the POME in open anaerobic and aerobic lagoons or open tanks. While open lagoon systems are most commonly used by the Malaysian palm oil industry (about 85% of mills in operation), open tank systems are adopted by a 10-15% of mills in Malaysia[11].

Only two other biogas projects similar to the proposed project activity have been implemented in palm oil mills in the past without the support of CDM [12]. These are:

1. The Keck Seng (Malaysia) Berhad installed a biogas plant in 1984. The biogas plant is based on tank digesters and the biogas is utilized in steam boilers in a palm oil refinery at the industrial complex of Keck Seng, where the mill is also located. The captured biogas is displacing expensive fossil fuels (diesel) and thereby has a possibility of generating significant project revenues.

2. The Tennamaram mill at Batang Berjuntai, Selangor, was the first biogas plant to be implemented in a palm oil mill in Malaysia. The biogas was initially used for power generation in biogas engines which displaced power generation by diesel gensets and utilized in steam boilers. The

[10] MPOB, Malaysian Oil Palm Statistics 2007, http://econ.mpob.gov.my/economy/annual/stat2007/Processing2.1.htm

[11] Ministry of Energy, Water and Communications, PTM, DANIDA (December 2004). Study on Clean Development Mechanism Potential in the Waste Sectors in Malaysia

[12] Ministry of Energy, Water and Communications, PTM, DANIDA (December 2004). Study on Clean Development Mechanism Potential in the Waste Sectors in Malaysia (Pages 49)

engines are no longer operational and the biogas is being flared[13]. The generation of power for the mill is displacing expensive fossil fuels (diesel) from the gensets and thereby has a possibility of generating significant project revenues.

As only two biogas projects have been implemented in the past without support from CDM and these two plants were able to have a use for the biogas that resulted in fossil fuel savings. Both the plants were installed in the early 1980's, and no other plants have been implemented in the period up to mid-2000, it is concluded that open anaerobic lagoons or open anaerobic tanks, and not biogas plants, is the prevailing practice for the treatment of POME in Malaysia.

Sub-step 4b: Discuss any similar Options that are occurring:
As presented in Sub-step 4a, there are only two biogas projects implemented in Malaysia without CDM and it can be concluded that biogas technology similar to the project activity is not widely observed or commonly carried out. Both projects were implemented in the 1980's and the technology has never gained momentum in the Malaysian palm oil sector. As explained by the barriers presented under step 3 there is no demand for the biogas and the biogas will be displacing biomass waste in the proposed project as opposed to the two existing projects where biogas was used for displacing fossil fuels.

Conclusion

The use of biogas technology in the palm oil mills is marginal as only two mills have implemented biogas plants without CDM which constitutes about 0.5% of all mills. Both projects use the gas to displace fossil fuels. This confirms that barriers exists that prevent biogas plants from being implemented by the palm oil sector.

The existing wastewater treatment system at the mill is able to comply with the legal discharge standard as stipulated by the Department of Environment, Malaysia. The open anaerobic lagoon system is the prevailing practice of palm oil mills in Malaysia. There is no legal requirement or incentive for mill owners to change their prevailing practice and implement alternative options. Therefore, the continuation of the existing open anaerobic lagoon system requires no further investment and has the lowest technological risk.

Biogas technology is associated with greater risk of technological failure as utilization and combustion of biogas in boilers can lead to corrosion due to the presence of hydrogen sulphide. Further research into mitigation measures and trials is needed.

Biogas is an explosive gas and even though mitigation measures are implemented the risk of explosions can never be fully mitigated. The probability of an incident occurring and the impact of an incident is difficult to quantify since sufficient data is not available.

CDM can alleviate the identified technological barriers that prevent the project from being implemented by providing additional revenues to the project. The potential CDM revenue is significant when put into relation to the total cost of the project. The total amount of CDM revenues throughout the crediting period

[13] Ministry of Energy, Water and Communications, PTM, DANIDA (December 2004). Study on Clean Development Mechanism Potential in the Waste Sectors in Malaysia (Pages 101-104)

are expected to be more than MYR 5 mil.[14] which is significant when put into relation to the total expected cost of the project estimated at MYR 5.5[15] mil. as presented to the board.

The project is therefore demonstrated to be additional.

[14] MYR 5 Mill = 25 MYR/CER * 215,335 CER/year. Based on an expected average price of 25 MYR/CER and a total expected amount of CERs of 215,335 during the crediting period

[15] The total cost of 5.5 Mill is based on the expected capital expenditure approved by the board.

B.6. Emission reductions:

B.6.1. Explanation of methodological choices:

The approved baseline methodology AMS III.H version 13 "Methane Recovery in Wastewater Treatment" is applied for the calculation of Baseline Emissions, Project Emissions, Leakage, and Emission Reductions.

Baseline Emissions

Baseline emissions are calculated using the formula

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

Where:

BE_y	Baseline emissions in year *y* (tCO_2e)
$BE_{power,y}$	Baseline emissions from electricity or fuel consumption in year *y* (tCO_2e)
$BE_{ww,treatment,y}$	Baseline emissions of the wastewater treatment systems affected by the project activity in year *y* (tCO_2e)
$BE_{s,treatment,y}$	Baseline emissions of the sludge treatment systems affected by the project activity in year *y* (tCO_2e)
$BE_{ww,discharge,y}$	Baseline methane emissions from degradable organic carbon in treated wastewater discharged into sea/river/lake in year *y* (tCO_2e).
$BE_{s,final,y}$	Baseline methane emissions from anaerobic decay of the final sludge produced in year *y* (tCO_2e).

$BE_{power,y}$ is zero. The current wastewater treatment system consumes power for pumping raw POME from the mill to the cooling pond. This pump will not be affected by project activity and is outside the project boundary. Power is also consumed for pumping treated POME from the last aerobic pond into furrows for land application. This pump will also not be affected by the project activity as the amount of treated wastewater will be the same. This pump is located within the project boundary and shall therefore be included in the calculation of project and baseline emissions. However, since the pump remains the same and will not be affected by the project activity, it is demonstrated that for the case of the land application pump:

$$BE_{power,land\ application,y} = PE_{power,land\ application,y}$$

Thus, $BE_{power,y}$ is zero and the pump used for land application is excluded from the project boundary and shall not be monitored as it is demonstrated that it has a negligible impact on the calculation of emission reductions.

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

$$BE_{ww,treatment,y} = \sum_i Q_{ww,i,y} * COD_{removed,i,y} * MCF_{ww,treatment,BL,i} * B_{o,ww} * UF_{BL} * GWP_{CH4}$$

Where:

$Q_{ww,i,y}$	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 baseline wastewater treatment systems *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 of 0.21 kg CH_4/kg COD)
UF_{BL}	Model correction factor to account for model uncertainties (0.94)
GWP_{CH4}	Global Warming Potential for methane (value of 21)

Methane emission from the baseline sludge treatment system affected by the project activity is determined using the methane generation potential of the sludge treatment system:

$$BE_{s,treatment,y} = \sum_j S_{j,BL,y} * MCF_{s,treatment,BL,j} * DOC_s * UF_{BL} * DOC_F * F * 16/12 * GWP_{CH4}$$

Where:

$S_{j,BL,y}$	Amount of dry matter in the sludge that would have been treated by the sludge treatment system *j* in the baseline scenario (tonne)
j	Index for baseline sludge treatment system
DOC_s	Degradable organic content of the untreated sludge generated in the year *y* (fraction, dry basis). Default values of 0.257 for industrial sludge shall be used.
$MCF_{s,treatment,BL,j}$	Methane correction factor for the baseline sludge treatment system *j* (MCF values as per table III.H.1)
UF_{BL}	Model correction factor to account for model uncertainties (0.94)
DOC_F	Fraction of DOC dissimilated to biogas (IPCC default value of 0.5)
F	Fraction of CH_4 in biogas (IPCC default of 0.5)

Sludge is used for soil application in aerobic conditions and this baseline emission is therefore negligible.

Methane emissions from degradable organic carbon in treated wastewater discharged in e.g., a river, sea or lake in the baseline situation are determined as follows:

$$BE_{ww,discharge,y} = Q_{ww,y} * GWP_{CH4} * B_{o,ww} * UF_{BL} * COD_{ww,discharge,BL,y} * MCF_{ww,BL,discharge}$$

Where:

$Q_{ww,y}$	Volume of treated wastewater discharged in year *y* (m^3)
UF_{BL}	Model correction factor to account for model uncertainties (0.94)
$COD_{ww,discharge,BL,y}$	Chemical oxygen demand of the treated wastewater discharged into sea, river or lake in the baseline situation in the year *y* (tonnes/m^3).
$MCF_{ww,BL,discharge}$	Methane correction factor based on discharge pathway in the baseline situation (e.g., into sea, river or lake) of the wastewater (fraction) (MCF values as per table III.H.1)

Treated wastewater is used for soil application in aerobic conditions and this baseline emission is therefore negligible ($MCF_{ww,BL,discharge} = 0.0$).

Methane emission from anaerobic decay of the final sludge produced is determined as follows:

$$BE_{s,final,y} = S_{final,BL,y} * DOC_s * UF_{BL} * MCF_{s,BL,final} * DOC_F * F * 16/12 * GWP_{CH4}$$

Where:

$S_{final,BL,y}$	Amount of dry matter in final sludge generated by the baseline wastewater treatment systems in the year *y* (tonnes).
$MCF_{s,BL,final}$	Methane correction factor of the disposal site that receives the final sludge in the baseline situation, estimated as per the procedures described in AMS-III.G
UF_{BL}	Model correction factor to account for model uncertainties (0.94)

Final sludge produced is used for soil application in aerobic conditions and this baseline emission is therefore negligible.

There are no methane emissions from stored biomass in the baseline scenario since biomass is stored aerobically outdoor for less than two months. Procedures for storage of biomass in the baseline scenario are the same as those that will be applied in the project activity.

<u>Project Activity Emissions</u>

Project activity emissions are calculated using the formula

$$PE_y = \left\{ \begin{matrix} PE_{power,y} + PE_{ww,treatment,y} + PE_{s,treatment,y} + PE_{ww,discharge,y} + PE_{s,final,y} + \\ PE_{fugitive,y} + PE_{biomass,y} + PE_{flaring,y} \end{matrix} \right\}$$

Where:

PE_y	Project activity emissions in the year *y* (tCO_2e).
$PE_{power,y}$	Emissions from electricity or fuel consumption in the year *y* (tCO_2e).
$PE_{ww,treatment,y}$	Methane emissions from wastewater treatment systems affected by the project activity, and not equipped with biogas recovery, in year *y* (tCO_2e).
$PE_{s,treatment,y}$	Methane emissions from sludge treatment systems affected by the project activity, and not equipped with biogas recovery, in year *y* (tCO_2e).
$PE_{y,ww,discharge}$	Methane emissions from degradable organic carbon in treated wastewater in year *y* (tCO_2e).
$PE_{s,final,y}$	Methane emissions from anaerobic decay of the final sludge produced in year *y* (tCO_2e).
$PE_{fugitive,y}$	Methane emissions from biogas release in capture systems in year *y* (tCO_2e).
$PE_{flaring,y}$	Methane emissions due to incomplete flaring in year *y* (tCO_2e).
$PE_{biomass,y}$	Methane emissions from biomass stored under anaerobic conditions (tCO_2e).

Project emissions from electricity or fuel consumption ($PE_{power,y}$) in the year *y* (tCO2e) are calculated as per AMS III.H Version 13, paragraph 26, "emissions shall be calculated as per paragraph 19, for the situation of the project scenario". As per paragraph 19, in AMS III.H. Version 13, "emissions from electricity consumption are determined as per the procedures described in AMS-I.D.". In accordance with AMS I.D. paragraph 11(b), project emissions from consumption of electricity ($PE_{power,y}$) are calculated using: the weighted average emissions (in kg CO_2e/kWh) of the current generation mix and the data of the year in which project generation occurs. Project emissions from electricity consumption by pumps used for land application is exclude as the power consumption in the project activity is equal to the power consumption in the baseline (refer to baseline emission calculations for power consumption: $BE_{power,land\ application,y} = PE_{power,land\ application,y}$).
In the project activity, the total quantity of electricity consumed by the project activity (excluding pumps used for land application) will be measured by a single electric meter. Project emissions from electricity consumption will be calculated as follows:

$$PE_{power,y} = EC_{PJ,y} * \sum_j \frac{EG_{j,y}}{\sum_j EG_{j,y}} * EF_{j,y}$$

Where:

$PE_{power,y}$	Project emissions from electricity consumption in year y (tCO_2)
$EC_{PJ,y}$	Quantity of electricity consumed by the project activity in year y (MWh).
$EG_{j,y}$	Electricity generation by electricity generation source j in year y (MWh)
j	Sources of electricity generation (i.e. TNB (Grid), Diesel Genset & Biomass

Boiler)

$EF_{j,y}$ Emission factor for electricity generation source j in year y (tCO_2/MWh)

Where j = {TNB, Genset, Biomass} and $EF_{Biomass} = 0$, the full form of the equation $PE_{power,y}$ is reduced to:

$$PE_{power,y} = EC_{PJ,y} * [\ (\frac{EG_{TNB,y}}{EG_{TNB,y} + EG_{Biomass,y} + EG_{Genset,y}}) * EF_{TNB,y} + (\frac{EG_{Genset,y}}{EG_{TNB,y} + EG_{Biomass,y} + EG_{Genset,y}}) * EF_{Genset,y}\ ]$$

Methane emissions from wastewater treatment systems affected by the project activity, and not equipped with biogas recovery, in year *y* (tCO_2e) are calculated as per equation

$$PE_{ww,treatment,y} = \sum_i Q_{ww,i,y} * COD_{removed,PJ,k,y} * MCF_{ww,treatment,PJ,k} * B_{o,ww} * UF_{PJ} * GWP_{CH4}$$

Where:

UF_{PJ} = 1.06 and $MCF_{ww,treatment,PJ,k}$ as per MCF values in table III.H.1. Since this value is zero (Aerobic treatment, well managed), this project emission is zero.

Table III.H.1. IPCC default values for Methane Correction Factor (MCF)

Type of wastewater treatment and discharge pathway or system	MCF value
Discharge of wastewater to sea, river or lake	0.1
Aerobic treatment, well managed	0.0
Aerobic treatment, poorly managed or overloaded	0.3
Anaerobic digester for sludge without methane recovery	0.8
Anaerobic reactor without methane recovery	0.8
Anaerobic shallow lagoon (depth less than 2 metres)	0.2
Anaerobic deep lagoon (depth more than 2 metres)	0.8
Septic system	0.5

Methane emissions from sludge treatment systems affected by the project activity, and not equipped with biogas recovery, in year *y* (tCO_2e) are calculated as per equation

$$PE_{treatment,s,y} = \sum_j S_{l,PJ,y} * MCF_{s,treatment,l} * DOC_s * UF_{PJ} * DOC_F * F * 16/12 * GWP_{CH4}$$

Where:

$S_{l,PJ,y}$ Amount of dry matter in the sludge treated by the sludge treatment system *l* in the project scenario in year *y* (tonne)

j Index for baseline sludge treatment system

DOC_s	Degradable organic content of the untreated sludge generated in the year *y* (fraction, dry basis). Default values of 0.5 for domestic sludge and 0.257 for industrial sludge shall be used.
$MCF_{s,treatment,l}$	Methane correction factor for the project sludge treatment system l (MCF values as per table III.H.1)
UF_{PJ}	Model correction factor to account for model uncertainties (1.06)
DOC_F	Fraction of DOC dissimilated to biogas (IPCC default value of 0.5)
F	Fraction of CH_4 in biogas (IPCC default of 0.5)

Currently, as well as after implementation of the project activity, sludge is treated aerobically in a well managed system and used for soil application and this project emission is therefore zero. However, treatment of sludge will be monitored during the crediting period.

Methane emissions from degradable organic carbon in treated wastewater in year *y* (tCO_2e) are calculated as per equation

$$PE_{ww,discharge,y} = Q_{ww,y} * GWP_{CH4} * B_{o,ww} * UF_{PJ} * COD_{ww,discharge,PJ,y} * MCF_{ww,PJ,discharge}$$

Where:

$Q_{ww,y}$	Volume of treated wastewater discharged in year *y* (m^3)
UF_{PJ}	Model correction factor to account for model uncertainties (1.06)
$COD_{ww,discharge,PJ,y}$	Chemical oxygen demand of the treated wastewater discharged into sea, river or lake in the project situation in year *y* ($tonnes/m^3$)
$MCF_{ww,PJ,discharge}$	Methane correction factor based on discharge pathway in the project situation (e.g., into sea, river or lake) of the wastewater (fraction) (MCF values as per table III.H.1)

Treated waste water is discharged to aerobic treatment and subsequently used for soil application in a well managed system and this project emission is therefore zero ($MCF_{ww,PJ,discharge} = 0.0$).

Methane emissions from anaerobic decay of the final sludge produced in year *y* (tCO_2e) are calculated as per equation

$$PE_{s,final,y} = S_{final,PJ,y} * DOC_s * UF_{PJ} * MCF_{s,PJ,final} * DOC_F * F * 16/12 * GWP_{CH4}$$

Where:

$S_{final,PJ,y}$	Amount of dry matter in final sludge generated by the project wastewater treatment systems in the year *y* (tonnes)
$MCF_{s,PJ,final}$	Methane correction factor of the disposal site that receives the final sludge in the project situation, estimated as per the procedures described in AMS-III.G
UF_{PJ}	Model correction factor to account for model uncertainties (1.06)

Final sludge is used for soil application under aerobic conditions in a well managed system and this project emission is therefore negligible.

Project activity emissions from methane release in capture systems are determined as follows:

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

Where:

$PE_{fugitive,ww,y}$	Fugitive emissions through capture inefficiencies in the anaerobic wastewater treatment systems in the year *y* (tCO_2e)
$PE_{fugitive,s,y}$	Fugitive emissions through capture inefficiencies in the anaerobic sludge treatment systems in the year *y* (tCO_2e)

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

Where:

CFE_{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)

$$MEP_{ww,treatment,y} = Q_{ww,y} * B_{o,ww} * UF_{PJ} * \sum_{k} COD_{removed,PJ,k,y} * MCF_{ww,treatment,PJ,k}$$

Where:

$COD_{removed,PJ,k,y}$	The chemical oxygen demand removed[16] 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)
UF_{PJ}	Model correction factor to account for model uncertainties (1.06)

$$PE_{fugitive,s,y} = (1 - CFE_{s}) * MEP_{s,treatment,y} * GWP_{CH4}$$

Where:

CFE_{s}	Capture efficiency of the biogas recovery equipment in the sludge treatment systems (a default value of 0.9 shall be used)
$MEP_{s,treatment,y}$	Methane emission potential of the sludge treatment systems equipped with biogas recovery system in year *y* (tonne)

$$MEP_{s,treatment,y} = \sum_{l} (S_{PJ,l,y} * MCF_{s,treatment,PJ,l}) * DOC_{s} * UF_{PJ} * DOC_{F} * F * 16/12$$

[16] Difference of inflow COD and the outflow COD.

Where:

$S_{PJ,l,y}$	Amount of sludge treated in the project sludge treatment system *l* equipped with biogas recovery system (on dry basis) in year *y* (tonne)
$MCF_{s,treatment,PJ,l}$	Methane correction factor for the sludge treatment system equipped with biogas recovery equipment (MCF values as per table III.H.1)
UF_{PJ}	Model correction factor to account for model uncertainties (1.06)

Ex post project emissions (tCO_2e) due to incomplete flaring in year *y* ($PE_{flare,y}$) for a closed flare with default value is determined as per the "Tool to determine project emissions from flaring gases containing methane".

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

Where:

$TM_{RG,h}$	Mass flow rate of methane flared in the hour h (kg/h)
$\eta_{flare,h}$	Flare efficiency in the hour h
GWP_{CH4}	Global warming potential of methane valid for the commitment period (tCO2e/tCH4)

Ex ante project emissions (tCO_2e) due to incomplete flaring in year *y* ($PE_{flare,y}$) for a closed flare with default value is determined based on the percentage of biogas flared, the amount of biogas captured and the flare efficiency as follows:

$$PE_{flare,y} = \text{(percentage of biogas flared)} * (BE_{ww,treatment,y} - PE_{fugitive,ww,y}) * (1 - \eta_{\text{flare,y}})$$

Where:

$PE_{flare,y}$	Project emissions from flaring in year *y* (tCO_2e)
$BE_{ww,treatment,y}$	Baseline emissions from waste water treatment in the year *y* (tCO_2e)
$PE_{fugitive,ww,y}$	Fugitive project emissions from waste water treatment in the year y (tCO_2e)
$\eta_{\text{flare,y}}$	Flare efficiency in year *y* (fraction)

It is estimated based upon mill operation hours (5400h) and a biogas storage capacity (2h/day) that 70% of the captured biogas will be combusted gainfully at a methane destruction efficiency of 100% in the

boiler[17] and that the remaining 30% of the captured biogas is flared in a closed flare at a default efficiency of 90%. Thus, ex-ante emissions are determined using the following equation:

$$PE_{flare,y} = 0.3 * (BE_{ww,treatment,y} - PE_{fugitive,ww,y}) * 0.1$$

Methane emissions from biomass stored under anaerobic conditions ($PE_{biomass,y}$) are determined in accordance with the requirements stated in AMS III.H Ver 13 paragraph 26 "Methane emissions from biomass stored under anaerobic conditions which does not take place in the baseline situation ($PE_{biomass,y}$)" and footnote 11 "For instance in the baseline situation Palm Kernel Shells (PKS) are used as fuel in a boiler. In the project situation PKS is replaced by biogas captured at a wastewater treatment system. The PKS will no longer be used as fuel in the boiler, but sold on the market. Before it is sold it is likely it will be stored for a period of time (few months or longer) on site which might lead to methane emissions from anaerobic decay."

Displaced biomass will be sold as biomass fuel and used for energy production purposes. As the saved biomass will be sold to other consumers of biomass who use it for energy production, it will only be stored for a limited time, less than 2 months before being distributed to the customers. The mill is already selling excess biomass (PKS) to customers and the purpose of the storage of biomass is only to ensure a quantity that is large enough for arranging the bulk sale of biomass. As the amount of excess biomass is being increased by the project, the time to develop a quantity large enough for bulk sale is reduced and thus the biomass will be stored for a shorter time period than before the project implementation.

The biomass storage area is exposed to ventilation, ensuring that the biomass is not undergoing anaerobic digestion, which would reduce the quantity and quality of the biomass and thus reduce the revenue from selling the biomass to customers.

In conclusion, in the project activity emissions from storing biomass are negligible as the project activity will increase the turnover of stored biomass and thereby reduce the time during which biomass is stored when compared to the baseline scenario. The time will be reduced to a period well below the conditions for anaerobic decay i.e. "few months or longer" Thus,

$PE_{biomass,y} = 0$

Leakage

In this project activity the equipment is new and not transferred from any other activity. Based on this condition, leakage due to project activity is therefore negligible and shall not be considered; Leakage = 0 (tCO_2/y).

Emission Reduction (*Ex ante*)

Emission reductions are estimated *ex ante* using the equations provided in the baseline, project and leakage emissions sections above. Emission reductions are estimated *ex ante* as follows:

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

[17] SSC WG 22 paragraph 29

Where:

$ER_{y,ex\ ante}$	*Ex ante* emission reduction in year *y* (tCO_2e)
$LE_{y,ex\ ante}$	*Ex ante* leakage emissions in year *y* (tCO_2e)
$PE_{y,ex\ ante}$	*Ex ante* project emissions in year *y* (tCO_2e)
$BE_{y,ex\ ante}$	*Ex ante* baseline emissions in year *y* (tCO_2e)

<u>Emission Reduction (*Ex post*)</u>

Ex post emission reductions are determined based on the lowest value of the following:

(i) The amount of biogas recovered and fuelled or flared (MD_y) during the crediting period, that is monitored *ex post*;

(ii) *Ex post* calculated baseline, project and leakage emissions based on actual monitored data for the project activity.

Emission reductions achieved by the project activity is limited to the *ex post* calculated baseline emissions minus project emissions using the actual monitored data for the project activity. The emission reductions achieved in any year are the lowest value of the following:

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

Where:

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

$BE_{y,ex\ post}$ Baseline emissions calculated as per

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

using *ex post* monitored values

$PE_{y,ex\ post}$ Project emissions calculated as per

$$PE_y = \left\{\begin{matrix} PE_{power,y} + PE_{ww,treatment,y} + PE_{s,treatment,y} + PE_{ww,discharge,y} + PE_{s,final,y} + \\ PE_{fugitive,y} + PE_{biomass,y} + PE_{flaring,y} \end{matrix}\right\}$$

using *ex post* monitored values

MD_y Methane captured, flared and gainfully used by the project activity in the year *y* (tCO_2e)

MD_y will be measured using the conditions of the flaring process:

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

Where:

$BG_{burnt,y}$	Biogas flared and combusted in year *y* (m^3)
$w_{CH4,y}$	Methane content in the biogas in the year *y* (mass fraction)
D_{CH4}	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)

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

Data / Parameter:	Anaerobic lagoon treatment system depth
Data unit:	M
Description:	Depth of the anaerobic lagoons
Source of data used:	Project proponent
Value applied:	3 m
Justification of the choice of data or description of measurement methods and procedures actually applied :	Depth of anaerobic lagoons provided by project proponent.
Any comments	-

Data / Parameter:	$B_{0,ww}$
Data unit:	kg CH4 per kg COD
Description:	The rate of conversion of COD to CH4 within the wastewater
Source of data used:	AMS III H Version 13
Value applied:	0.21 kg CH4 per kg COD
Justification of the choice of data or description of measurement methods and procedures actually applied :	IPCC default value
Any comment:	-

Data / Parameter:	$MCF_{ww, treatment}$
Data unit:	Fraction
Description:	Methane correction factor for waste water treatment system that will be equipped with methane recovery and combustion
Source of data used:	AMS. III. H Version 13
Value applied:	0.8
Justification of the choice of data or description of measurement methods and procedures actually applied :	Since the depths of the anaerobic lagoons are more than 2 meters they fall into the type of anaerobic deep lagoon based on AMS. III. H, table III.H.1
Any comment:	-

Data / Parameter:	$MCF_{ww, discharge}$
Data unit:	Fraction
Description:	Methane correction factor based on discharge pathway of the wastewater
Source of data used:	AMS. III. H Version 13

Value applied:	0
Justification of the choice of data or description of measurement methods and procedures actually applied :	After anaerobic treatment, POME is treated in open aerobic lagoons and is finally used for soil application.
Any comment:	-

Data / Parameter:	**GWP_CH4**
Data unit:	Factor
Description:	Global Warming Potential of Methane
Source of data used:	AMS.III.H Version 13
Value applied:	21
Justification of the choice of data or description of measurement methods and procedures actually applied :	AMS.III.H Version 13
Any comments	-

Data / Parameter:	**$EF_{TNB,y}$**
Data unit:	tCO_2/MWh
Description:	Grid Emission Factor (Peninsular Malaysia)
Source of data used:	PTM, Study on Grid Connected Electricity Baselines in Malaysia (2007)
Value applied:	0.684 t CO2/MWh
Justification of the choice of data or description of measurement methods and procedures actually applied :	The study is made by Pusat Tenaga Malaysia and is available at http://cdm.eib.org.my/. It is based on three years data. The value is fixed ex-ante throughout the period of the project activity.
Any comments	-

Data / Parameter:	**$EF_{genset,y}$**
Data unit:	tCO_2/MWh
Description:	Diesel Genset Emission factor
Source of data used:	UNFCCC conservative default value.
Value applied:	0.8 tCO_2/MWh
Justification of the choice of data or description of measurement methods and procedures actually applied :	IPCC conservative default value for project electricity consumption for diesel generator systems > 200 kW in accordance with AMS I.D. Version 15 Table I.D.1
Any comments	-

Data / Parameter:	**$EF_{biomass,y}$**
Data unit:	tCO_2/MWh
Description:	Biomass boiler Emission factor
Source of data used:	UNFCCC
Value applied:	0.0 tCO_2/MWh
Justification of the choice of data or description of measurement methods and procedures actually applied :	Emission factor of electricity consumption from a biomass fired boiler is carbon neutral.
Any comments	-

Data / Parameter:	**UF_{bl}**
Data unit:	-
Description:	Model correction factor to account for model uncertainties (0.94)
Source of data used:	UNFCCC
Value applied:	0.94
Justification of the choice of data or description of measurement methods and procedures actually applied :	AMS III.H Version 13 paragraph 20.
Any comments	-

Data / Parameter:	**UF_{pj}**
Data unit:	-
Description:	Model correction factor to account for model uncertainties (1.06)
Source of data used:	UNFCCC
Value applied:	1.06
Justification of the choice of data or description of measurement methods and procedures actually applied :	AMS III.H Version 13 paragraph 27.
Any comments	-

Data / Parameter:	**DOC_F**
Data unit:	-
Description:	Fraction of degradable organic carbon (DOC) dissimilated to biogas (IPCC default value of 0.5)
Source of data used:	UNFCCC
Value applied:	0.5
Justification of the choice of data or	AMS III.H Version 13 paragraph 22.

description of measurement methods and procedures actually applied :	
Any comments	-

Data / Parameter:	**CFE_{ww}**
Data unit:	-
Description:	Capture efficiency of the biogas recovery equipment in the wastewater treatment systems (a default value of 0.9 shall be used)
Source of data used:	UNFCCC
Value applied:	0.9
Justification of the choice of data or description of measurement methods and procedures actually applied :	AMS III.H Version 13 paragraph 22.
Any comments	-

B.6.3 Ex-ante calculation of emission reductions:

Ex ante emission reductions are calculated using equations explained in section B.6.1. Data is based on forecasted FFB production for year 2011 and a POME generation factor of 0.75 (Annex 3).

Year	Throughput (t FFB/yr)	POME factor (m^3/tFFB)	Volume of POME (m^3/yr)
2011	170,000	0.75	127,500

Baseline Emissions

Baseline emissions are based on historical data, but as 1 year data is not available a measurement campaign for more than 10 days (actual campaign was for 13 days) has been carried out in accordance with paragraph 18 in AMS.III.H ver.13. Other parameters such as power consumption, dry matter in sludge and final sludge generated per tonne of COD treated is not determined in the baseline, as these are not to be used in the emission reduction calculations. This is justified by the following:

1. Power consumption is expected to be unchanged as the lagoon treatment will still be in operation and consume power. It is conservative to exclude this power consumption, as it is expected to be lower in the project and thus lead to emission reductions.
2. No sludge is treated in the baseline system and thus sludge is not included in the project boundary.
3. Final sludge generated by the baseline system is only removed every 3-5 years and slugde is applied for land as fertiliser, which does not lead to anaerobic digestion and MCF=0, so the baseline emission will be zero. Again it is conservative not to include any possible emissions from this source in the baseline.

In relation to the paragraph 19 in AMS.III.H ver 13, The power consumption in the baseline is expected to be unchanged after the implementation of the project as the quantity of waste water that will be pumped will be the same or less. Therefore the value of $BE_{power,landapplication,y} = PE_{power,landapplication,y}$. Therefore the baseline values for electricity consumption are excluded from the baseline measurement campaign.

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

$BE_{power,y} = \underline{0}$ (Negligible)

$$BE_{ww,treatment,y} = \sum_i Q_{ww,i,y} * COD_{removed,i,y} * MCF_{ww,treatment,BL,i} * B_{o,ww} * UF_{BL} * GWP_{CH4}$$

$BE_{ww,treatment,y}$ = 127,500 m^3 * 0.0548 tonnes/ m^3 * 0.8 * 0.21 kg CH_4 /kg COD * 0.94 * 21

$BE_{ww,treatment,y}$ = $\underline{23{,}171 \text{ t } CO_{2e}}$

$$BE_{s,treatment,y} = \sum_j S_{j,BL,y} * MCF_{s,treatment,BL,j} * DOC_s * UF_{BL} * DOC_F * F * 16/12 * GWP_{CH4}$$

$MCF_{s,treatment,BL,j} = 0.0$

$BE_{s,treatment,y} = \underline{0}$

$$BE_{ww,discharge,y} = Q_{ww,y} * GWP_{CH4} * B_{o,ww} * UF_{BL} * COD_{ww,discharge,BL,y} * MCF_{ww,BL,discharge}$$

$MCF_{ww,BL,discharge} = 0.0$

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

$$BE_{s,final,y} = S_{final,BL,y} * DOC_s * UF_{BL} * MCF_{s,BL,final} * DOC_F * F * 16/12 * GWP_{CH4}$$

$MCF_{s,BL,final} = 0.0$

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

$BE_y = \underline{0}$ + **$\underline{23{,}171}$** $\underline{\text{t } CO_{2e}}$ + $\underline{0}$ + $\underline{0}$ + $\underline{0}$

BE_y = **$\underline{23{,}171 \text{ t } CO_{2e}}$**

Project Emissions

$$PE_y = \begin{Bmatrix} PE_{power,y} + PE_{ww,treatment,y} + PE_{s,treatment,y} + PE_{ww,discharge,y} + PE_{s,final,y} + \\ PE_{fugitive,y} + PE_{biomass,y} + PE_{flaring,y} \end{Bmatrix}$$

$$PE_{power,y} = EC_{PJ,y} * [\ (\frac{EG_{TNB,y}}{EG_{TNB,y} + EG_{Biomass,y} + EG_{Genset,y}}) * EF_{TNB,y} + (\frac{EG_{Genset,y}}{EG_{TNB,y} + EG_{Biomass,y} + EG_{Genset,y}}) * EF_{Genset,y} \ ]$$

$$PE_{power,y} = 701MWh * [\ (\frac{1{,}049MWh}{1{,}049MWh + 3{,}635MWh + 45MWh}) * 0.684\frac{tCO2}{MWh} + (\frac{1{,}049MWh}{1{,}049MWh + 3{,}635MWh + 45MWh}) * 0.8$$

$PE_{power,y}$ = <u>112 t CO_{2e}</u>

$$PE_{ww,treatment,y} = \sum_i Q_{ww,i,y} * COD_{removed,PJ,k,y} * MCF_{ww,treatment,PJ,k} * B_{o,ww} * UF_{PJ} * GWP_{CH4}$$

$$MCF_{ww,treatment,PJ,k} = 0.0$$

$$PE_{ww,treatment,y} = \underline{0}$$

$$PE_{treatment,s,y} = \sum_j S_{l,PJ,y} * MCF_{s,treatment,l} * DOC_s * UF_{PJ} * DOC_F * F * 16/12 * GWP_{CH4}$$

$$MCF_{s,treatment,l} = 0.0$$

$$PE_{treatment,s,y} = \underline{0}$$

$$PE_{ww,discharge,y} = Q_{ww,y} * GWP_{CH4} * B_{o,ww} * UF_{PJ} * COD_{ww,discharge,PJ,y} * MCF_{ww,PJ,discharge}$$

$$MCF_{ww,PJ,discharge} = 0.0$$

$$PE_{ww,discharge,y} = \underline{0}$$

$$PE_{s,final,y} = S_{final,PJ,y} * DOC_s * UF_{PJ} * MCF_{s,PJ,final} * DOC_F * F * 16/12 * GWP_{CH4}$$

$$MCF_{s,PJ,final} = 0.0$$

$$PE_{s,final,y} = \underline{0}$$

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

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

$$MEP_{ww,treatment,y} = Q_{ww,y} * B_{o,ww} * UF_{PJ} * \sum_{k} COD_{removed,PJ,k,y} * MCF_{ww,treatment,PJ,k}$$

$MEP_{ww,treatment,y}$ = 127,500 m^3 * 0.21 * 1.06 * 0.0524 tonnes/m^3 * 0.8

$MEP_{ww,treatment,y}$ = 1,190 t CH4

$PE_{fugitive,ww,y}$ = (1 - 0.9) * 1190 t CH4 * 21

$PE_{fugitive,ww,y}$ = 2,498 **t CO_{2e}**

$$PE_{fugitive,s,y} = (1 - CFE_s) * MEP_{s,treatment,y} * GWP_{CH4}$$

$$MEP_{s,treatment,y} = \sum_{l} (S_{PJ,l,y} * MCF_{s,treatment,PJ,l}) * DOC_s * UF_{PJ} * DOC_F * F * 16/12$$

$MCF_{s,treatment,PJ,l}$ = 0.0

$PE_{fugitive,s,y}$ = **0**

$PE_{fugitive,y} = PE_{fugitive,ww,y} + PE_{fugitive,s,y}$ **= 2,498 t CO_{2e} + 0 =** 2,498 t CO_{2e}

$PE_{biomass,y}$ = 0 (Negligible)

$PE_{flare,y}$ = 0.3 * ($BE_{ww,treatment,y}$ - $PE_{fugitive,ww,y}$) * 0.1
$PE_{flaring,y}$ = 0.3 * (23,171 t CO_{2e} - 2,498 t CO_{2e}) * 0.1
$PE_{flaring,y}$ = 620 t CO_{2e}

PE_y = 112 t CO_{2e} + 0 + 0 + 0 + 0 + 2,498 t CO_{2e} + 0 + 620 t CO_{2e}
PE_y = **3,230 t CO_{2e}**

Leakage Emissions

LE_y = **0**

Emission Reduction (*Ex ante*)

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

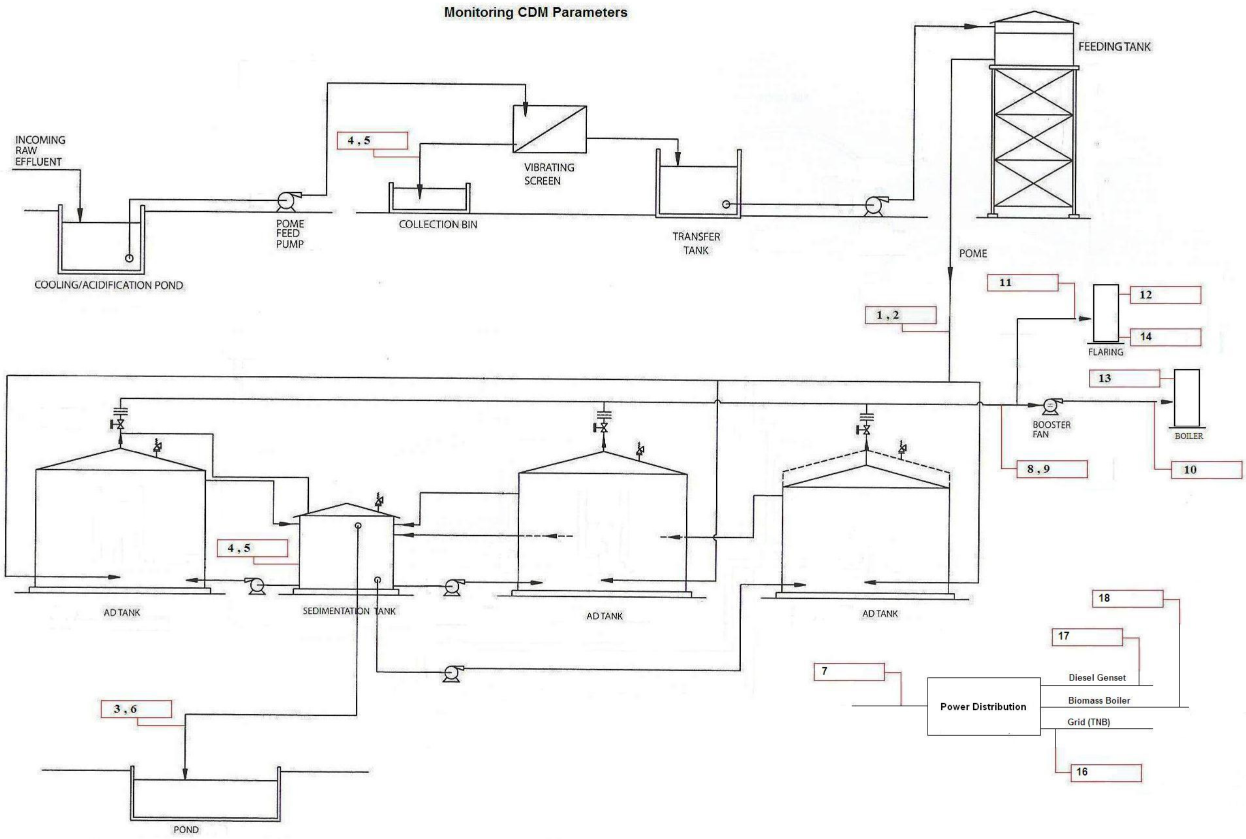
$ER_{y,ex\ ante}$ = 23,171 t CO_{2e} - (3,230 t CO_{2e} + 0)

$ER_{y,ex\ ante}$ = **19,941 t CO_{2e}**

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

Year	Baseline emission	Project emissions	Leakage	Emission reduction
2010 (15/10–31/12)	4,827	673	0	4,154
2011	23,171	3,230	0	19,941
2012	23,853	3,322	0	20,531
2013	24,534	3,414	0	21,120
2014	24,534	3,414	0	21,120
2015	25,079	3,487	0	21,592
2016	25,625	3,561	0	22,064
2017	26,170	3,634	0	22,536
2018	26,715	3,708	0	23,007
2019	27,260	3,781	0	23,479
2020 (1/1-14/10)	18,344	2,557	0	15,787
Total Estimated Reductions (tons of CO2e)				**215,335**

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



No	Parameter	Unit	Description
1	**$Q_{ww,y}$**	m^3	Volume of POME entering anaerobic treatment
2	**$COD_{ww,untreated,y}$**	Kg COD/m^3	COD entering anaerobic treatment
3	**$COD_{ww, treated, y}$**	Kg COD/m^3	COD leaving anaerobic treatment
4	**$MCF_{s,PJ,final}$**	Fraction	Sludge treatment methane correction factor
5	**$S_{final,PJ,y}$**	tonnes	Sludge dry matter
6	**$S_{PJ,y}$**	tonnes	Dry matter discharged to aerobic treatment
7	**$EC_{PJ,y}$**	MWh	Project electricity consumption
8	**$FV_{digester,h}$**	Nm^3/h	Rate of biogas produced
9	**$fv_{CH4,h}$**	Fraction	Methane fraction
10	**$FV_{boiler,h}$**	Nm^3/h	Rate of biogas to boiler
11	**$FV_{flare,h}$**	Nm^3/h	Rate of biogas to flare
12	**T_{Flare}**	°C	Flare temperature
13	**D_{Boiler}**	On/Off	Flame detection
14	**$Other_{Flare}$**	N/A	Flare operation
15	**Leakage**	N/A	Leakage detection
16	**$EG_{TNB,y}$**	kWh	Electricity generated from grid

17	**$EG_{genset,y}$**	kWh	Electricity generated from genset
18	**$EG_{biomass,y}$**	kWh	Electricity generated from biomass boiler

B.7.1 Data and parameters monitored:

Data / Parameter:	**$Q_{ww,y}$**
Data unit:	m^3
Description:	Flow of waste water from the palm oil mill
Source of data to be used:	Measurements by project participants
Value of data applied for the purpose of calculating expected emission reductions in section B.5	127,500 m^3 (year 1)
Description of measurement methods and procedures to be applied:	The effluent inflow will be monitored continuously by cumulative volumetric flow measuring meters. Data will be kept electronically in a systematic and transparent manner during crediting period and two years after crediting period. Instrument readings are recorded using the most conservative value (of instrument accuracy in accordance with manufacturer's specification).
QA/QC procedures to be applied:	Flow meter will be calibrated regularly in accordance with manufacturer's specification
Any comment:	Flow meters will be calibrated at least once a year.

Data / Parameter:	**$COD_{ww,untreated,y}$**
Data unit:	kg COD/m^3
Description:	Chemical oxygen demand entering the anaerobic treatment system with methane capture in the year y
Source of data to be used:	Measurements by project participants
Value of data applied for the purpose of calculating expected emission reductions in section B.5	65.5 kg COD/m^3
Description of measurement methods and procedures to be applied:	COD will be sampled and recorded on site monthly. Off-site analysis by an accredited laboratory adhering to internationally accepted standards will be conducted monthly. Instrument readings are recorded using the most conservative value (of instrument accuracy in accordance with manufacturer's specification).
QA/QC procedures to be applied:	Data will be kept electronically in a systematic and transparent manner during the crediting period and two years after the crediting period.
Any comment:	.-

Data / Parameter:	**$COD_{ww,treated,y}$**
Data unit:	kg COD / m^3
Description:	Chemical Oxygen Demand of the treated waste water
Source of data to be used:	Measurements by project participants
Value of data applied for the purpose of calculating expected emission reductions in section B.5	13.1 kg COD/m^3
Description of measurement methods and procedures to be applied:	COD will be sampled and recorded on site monthly. Off-site analysis by an accredited laboratory adhering to internationally accepted standards will be conducted monthly. Instrument readings are recorded using the most conservative value (of instrument accuracy in accordance with manufacturer's specification).
QA/QC procedures to be applied:	Data will be kept electronically in a systematic and transparent manner during the crediting period and two years after the crediting period.
Any comment:	-

Data / Parameter:	**$MCF_{s,PJ,final}$**
Data unit:	-
Description:	Methane correction factor of the disposal site that receives the final sludge
Source of data to be used:	Recordings by project participants
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0
Description of measurement methods and procedures to be applied:	The final disposal of the sludge will be monitored during the crediting period. For every disposal of sludge, date and disposal site will be recorded.
QA/QC procedures to be applied:	N/A
Any comment:	-

Data / Parameter:	**$S_{final,PJ,y}$**
Data unit:	Tonnes
Description:	Amount of final sludge generated by the project wastewater treatment system in the year y (tonnes dry matter).
Source of data to be used:	Measurements by project participants
Value of data applied for the purpose of calculating expected	0

emission reductions in section B.5	
Description of measurement methods and procedures to be applied:	The amount of final sludge will be weighed and recorded during the crediting period. For every disposal of sludge, date and amount (tonnes dry matter) will be recorded. Instrument readings are recorded using the most conservative value (of instrument accuracy in accordance with manufacturer's specification).
QA/QC procedures to be applied:	Scale and equipment for sampling moisture content will be calibrated in accordance with manufacturer's recommendations.
Any comment:	Moisture content will be sampled for each disposal of sludge to determine the percentage of dry matter.

Data / Parameter:	**$S_{PJ,y}$**
Data unit:	Tonnes/m^3
Description:	Amount of dry matter (tonnes dry mass) discharged to aerobic treatment (tonnes/ m^3) in the year y.
Source of data to be used:	Measurements by project participants
Value of data applied for the purpose of calculating expected emission reductions in section B.5	N/A
Description of measurement methods and procedures to be applied:	Dry matter content will be sampled and recorded monthly with each COD sample. Instrument readings are recorded using the most conservative value (of instrument accuracy in accordance with manufacturer's specification).
QA/QC procedures to be applied:	Data will be kept electronically in a systematic and transparent manner during the crediting period and two years after the crediting period.
Any comment:	-

Data / Parameter:	**$EC_{PJ,y}$**
Data unit:	MWh
Description:	Total amount of electricity consumed by the project activity in the year y.
Source of data to be used:	Measurements by project participants using an electric meter
Value of data applied for the purpose of calculating expected emission reductions in section B.5	701 MWh
Description of measurement methods and procedures to be applied:	This parameter will be measured continuously by electricity meter. Data will be kept electronically in a systematic and transparent manner during crediting period and two years after crediting period. Instrument readings are recorded using the most conservative value (of instrument accuracy in accordance with manufacturer's specification).
QA/QC procedures to be applied:	This parameter will be monitored by electricity meters which will be calibrated in accordance with the standard of Tenaga National Berhad (TNB)

Any comment:	-

Data / Parameter:	$\mathbf{FV_{digester,h}}$
Data unit:	Nm^3/h
Description:	Volumetric flow rate of the residual gas in dry basis at normal conditions in the hour h.
Source of data to be used:	Measurements by project participants using a flow meter.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	N/A
Description of measurement methods and procedures to be applied:	This parameter will be measured continuously by flow meters. Data will be kept electronically in a systematic and transparent manner during the crediting period and two years after the crediting period. Ensure that the same basis (dry or wet) is considered for this measurement and the measurement of volumetric fraction of all components in the residual gas when the residual gas temperature exceeds 60C. Instrument readings are recorded using the most conservative value (of instrument accuracy in accordance with manufacturer's specification).
QA/QC procedures to be applied:	Flow meters will be calibrated in accordance with the manufacturer's recommendation.
Any comment:	Volume in Nm^3/h, normalised to take into account pressure and temperature. Ensure that the same basis (dry or wet) is considered for this measurement and the measurement of volumetric fraction of methane in residual gas. Values to be averaged hourly or at a shorter time interval.

Data / Parameter:	$\mathbf{fv_{CH4,h}}$
Data unit:	Fraction
Description:	Fraction of methane in the biogas
Source of data to be used:	Measurements by project participants using a gas analyzer
Value of data applied for the purpose of calculating expected emission reductions in section B.5	N/A
Description of measurement methods and procedures to be applied:	The fraction of methane in the gas will be measured continuously using a gas analyzer. Values to be averaged hourly or at a shorter interval. Instrument readings are recorded using the most conservative value (of instrument accuracy in accordance with manufacturer's specification).
QA/QC procedures to be applied:	Flow meters will be calibrated in accordance with the manufacturer's recommendation. Data will be kept electronically in a systematic and transparent manner during the crediting period and two years after the end of crediting period.
Any comment:	Only methane content is measured. Remaining part of the residual gas is considered N2.

Data / Parameter:	**$FV_{boiler,h}$**
Data unit:	Nm^3/h
Description:	Volumetric flow rate of the residual gas combusted in the boiler in dry basis at normal conditions in the hour h
Source of data to be used:	Measurements by project participants using a flow meter
Value of data applied for the purpose of calculating expected emission reductions in section B.5	N/A
Description of measurement methods and procedures to be applied:	This parameter will be measured continuously by flow meters. Data will be kept electronically in a systematic and transparent manner during the crediting period and two years after the crediting period. Instrument readings are recorded using the most conservative value (of instrument accuracy in accordance with manufacturer's specification).
QA/QC procedures to be applied:	Flow meters will be calibrated in accordance with the manufacturer's recommendation.
Any comment:	Volume in Nm^3/h, normalised to take into account pressure and temperature. Ensure that the same basis (dry or wet) is considered for this measurement and the measurement of volumetric fraction of methane in residual gas. Values to be averaged hourly or at a shorter time interval.

Data / Parameter:	**$FV_{flare,h}$**
Data unit:	Nm^3/h
Description:	Volumetric flow rate of the residual gas flared in dry basis at normal conditions in the hour h
Source of data to be used:	Measurements by project participants using a flow meter
Value of data applied for the purpose of calculating expected emission reductions in section B.5	N/A
Description of measurement methods and procedures to be applied:	This parameter will be measured continuously by flow meters. Data will be kept electronically in a systematic and transparent manner during the crediting period and two years after the crediting period. Instrument readings are recorded using the most conservative value (of instrument accuracy in accordance with manufacturer's specification).
QA/QC procedures to be applied:	Flow meters will be calibrated periodically in accordance with the manufacturer's recommendation.
Any comment:	Volume in Nm^3/h, normalised to take into account pressure and temperature. Ensure that the same basis (dry or wet) is considered for this measurement and the measurement of volumetric fraction of methane in residual gas. Values to be averaged hourly or at a shorter time interval.

Data / Parameter:	**T_{Flare}**
Data unit:	°C
Description:	Temperature in the exhaust gas of the flare
Source of data to be used:	Measurements by project participants
Value of data applied for the purpose of calculating expected emission reductions in section B.5	>500
Description of measurement methods and procedures to be applied:	Measure the temperature of the exhaust gas stream in the flare continuously by a Type N thermocouple. A temperature above 500 ºC indicates that the enclosed flare is operating and that the combustion efficiency is 90%. Instrument readings are recorded using the most conservative value (of instrument accuracy in accordance with manufacturer's specification).
QA/QC procedures to be applied:	Thermocouples should be replaced or calibrated every year.
Any comment:	An excessively high temperature at the sampling point (above 700 ºC) may be an indication that the flare is not being adequately operated or that its capacity is not adequate to the actual flow. Temperature is measured to evaluate flare efficiency.

Data / Parameter:	**D_{Boiler}**
Data unit:	On/off
Description:	Detection of flame in boiler.
Source of data to be used:	Measurements by project participants
Value of data applied for the purpose of calculating expected emission reductions in section B.5	On
Description of measurement methods and procedures to be applied:	A flame detector system, either UV or thermocouple, will be incorporated in the boiler reporting electronically on a continuous basis to verify that the boiler combustion efficiency is 100%. Data will be archived electronically, minimum for two years after last issuance of CERs. Instrument readings are recorded using the most conservative value (of instrument accuracy in accordance with manufacturer's specification).
QA/QC procedures to be applied:	In accordance with supplier recommendations. Data uncertainty level will be low. The detection system will undergo maintenance subject to appropriate industry standards.
Any comment:	To confirm the 100% combustion efficiency of the burner in the boiler.

Data / Parameter:	**$Other_{Flare}$**
Data unit:	-
Description:	Includes all data and parameters that are required to monitor whether the flare

	operates within the range of operating conditions according to the manufacturer's specifications.
Source of data to be used:	Measurements by project participants
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Full compliance in accordance with manufacturer's specifications
Description of measurement methods and procedures to be applied:	Continuous monitoring in accordance with supplier's recommendations. Instrument readings are recorded using the most conservative value (of instrument accuracy in accordance with manufacturer's specification).
QA/QC procedures to be applied:	-
Any comment:	-

Data / Parameter:	$\eta_{flare,h}$
Data unit:	Fraction (minutes)
Description:	Efficiency of the enclosed flaring process in the hour h which is based on a measurement of the fraction of time in which gas is combusted.
Source of data to be used:	Measurements by project participants in accordance with "Tool to determine project emissions from flaring gases containing methane"
Value of data applied for the purpose of calculating expected emission reductions in section B.5	90% (The measured fraction of time in which the flare temperature is above 500 °C is more than 40 minutes during the hour h)
Description of measurement methods and procedures to be applied:	The fraction of time in which gas is combusted is measured to determine the flare efficiency. The flare efficiency depends on the fraction of time in which gas is combusted as follows: The flare efficiency in the hour h is: 0% if the temperature in the exhaust gas of the flare (T_{flare}) is below 500 °C for more than 20 minutes during the hour h . • 50%, if the temperature in the exhaust gas of the flare (T_{flare}) is above 500 °C for more than 40 minutes during the hour h, but the manufacturer's specifications on proper operation of the flare are not met at any point in time during the hour h. • 90%, if the temperature in the exhaust gas of the flare (T_{flare}) is above 500 °C for more than 40 minutes during the hour h and the manufacturer's specifications on proper operation of the flare are met continuously during the hour h. Instrument readings are recorded using the most conservative value (of instrument accuracy).
QA/QC procedures to be applied:	Regular maintenance will be carried out as recommended by manufacturer to ensure optimal operation of flare.
Any comment:	-

Data / Parameter:	**Leakage**
Data unit:	-
Description:	Detection of physical leakage of digester tanks for safety purposes.
Source of data to be used:	Measurements by project participants
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0
Description of measurement methods and procedures to be applied:	During implementation of project activity, any leakage detected during any month will be recorded and the leaks will be sealed with appropriate sealing material.
QA/QC procedures to be applied:	The upper gas-containing sections of the tank will be monitored quarterly by applying standard techniques for leak monitoring to ensure that no leakage takes place in the welding joints. Leakage if detected will be rectified carefully and safely to ensure that the leaked amount will be minimal.
Any comment:	-

Data / Parameter:	$\mathbf{EG_{TNB,y}}$
Data unit:	kWh
Description:	Quantity of electricity supplied to the mill from the grid in the year y.
Source of data to be used:	Measurements by project participants using an electricity meter
Value of data applied for the purpose of calculating expected emission reductions in section B.5	1,049 MWh (=1,049,002 kWh)
Description of measurement methods and procedures to be applied:	This parameter will be measured continuously by electricity meter. Data will be kept electronically in a systematic and transparent manner during crediting period and two years after crediting period. Instrument readings are recorded using the most conservative value (of instrument accuracy in accordance with manufacturer's specification).
QA/QC procedures to be applied:	This parameter will be monitored by electricity meters which will be calibrated in accordance with the standard of Tenaga National Berhad (TNB)
Any comment:	The amount of each source of electricity supplied to the project site is measured to calculate the fraction of each source supplied to the project activitiy.

Data / Parameter:	$\mathbf{EG_{genset,y}}$
Data unit:	kWh
Description:	Quantity of electricity generated from the genset in the year y.
Source of data to be used:	Measurements by project participants using an electricity meter
Value of data applied	45 MWh (=44,603 kWh)

for the purpose of calculating expected emission reductions in section B.5	
Description of measurement methods and procedures to be applied:	This parameter will be measured continuously by electricity meter. Data will be kept electronically in a systematic and transparent manner during crediting period and two years after crediting period. Instrument readings are recorded using the most conservative value (of instrument accuracy in accordance with manufacturer's specification).
QA/QC procedures to be applied:	This parameter will be monitored by electricity meters which will be calibrated in accordance with manufacturer's standard
Any comment:	The amount of each source of electricity supplied to the project site is measured to calculate the fraction of each source supplied to the project activitiy.

Data / Parameter:	**$EG_{biomass,y}$**
Data unit:	kWh
Description:	Quantity of electricity generated from the biomass boiler in the year y.
Source of data to be used:	Measurements by project participants using an electricity meter
Value of data applied for the purpose of calculating expected emission reductions in section B.5	3,635 MWh (=3,634,905 kWh)
Description of measurement methods and procedures to be applied:	This parameter will be measured continuously by electricity meter. Data will be kept electronically in a systematic and transparent manner during crediting period and two years after crediting period. Instrument readings are recorded using the most conservative value (of instrument accuracy in accordance with manufacturer's specification).
QA/QC procedures to be applied:	This parameter will be monitored by electricity meters which will be calibrated in accordance with manufacturer's standard
Any comment:	The amount of each source of electricity supplied to the project site is measured to calculate the fraction of each source supplied to the project activitiy.

B.7.2. Description of the monitoring plan:

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ULU BASIR has an operational and management structure in place to monitor emission reductions from the project activity.

The palm oil mill engineer will be responsible to assign his subordinates to collect and record the monitoring parameters and verify them monthly. All the data will be kept for at least two years after the crediting period in both hard copy and soft copy at UP Berhad, ULU BASIR Palm Oil Mill, Pantai Remis.

The CDM project coordinator in ULU BASIR Palm Oil Mill will receive and screen the monthly monitoring reports and may assign a third party consultant or in-house expertise to calculate the emission reduction and prepare annual monitoring reports. The CDM project coordinator will also be responsible for conducting internal audits on the monitoring procedures and parameters.

ULU BASIR CDM Project Coordinator

1. Receive and screen Monthly Monitoring reports for discrepancies and conduct corrective and preventive actions.
2. Compile Monthly and Annual Monitoring Reports.
3. Conduct internal audit on the monitoring data

CDM Consultant

1. Assist in conducting Internal Audit for CDM monitoring procedures and documentations
2. Assist in calculate Emission Reductions & Prepare Monitoring Report

ULU BASIR Palm Oil Mill Engineer

1. Formulate monitoring manual based on the plant operation procedure and equipment manual.
2. Internal audit and review monthly reports (QC)

Plant Engineer/ground staff

1. Measure and record raw data accordingly
2. Prepare monthly reports according to CDM monitoring procedures and send it to internal audit.

Special training will be provided to the biogas plant operators by the technology provider on the operational and maintenance procedures after the testing and commissioning period of the biogas plant. A CDM Monitoring Manual will be drafted and a brief training session will be provided by an appointed CDM consultant on the CDM monitoring parameters and the plan.

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

The baseline and monitoring study was completed on July 29, 2009 by:

Mr. Henrik Rytter Jensen
Danish Energy Management
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No.2, Persiaran Capsquare
50100 Kuala Lumpur

Mr. Tom Hansen
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Danish Energy Management is a CDM consultant to the Project and is not a project participant.

SECTION C. Duration of the project activity / crediting period

C.1 Duration of the project activity:

C.1.1. Starting date of the project activity:

6/7/2009

The award of the first contract related to the construction of the biogas plant constitutes the project starting date.

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

Technical lifetime: 20 years

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

C.2.1. Renewable crediting period

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

>>
N/A

C.2.1.2. Length of the first crediting period:

>>
N/A

C.2.2. Fixed crediting period:

C.2.2.1. Starting date:

15/10/10

C.2.2.2. Length:

10 years

SECTION D. Environmental impacts

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

The project activity will not have any adverse environmental impacts. Furthermore the activity does not fall under those that require Environmental Impact Assessment (EIA) by the host country. Palm oil mills are discharging their treated POME either for Land Application or to watercourse with discharge licenses being approved by local Department of Environment (DOE) under the Environmental Quality Regulations (1978) Palm Oil Effluent Discharge Standard annually on June each year. The discharge limit varies from state to state. However, the regulations do not specify the treatment technologies or requirement.

Rather than causing negative impacts to the environment, the project activity will provide the following environmental benefits:

- Reduction of methane emission.
- Generation of renewable energy.
- Significant reduction of odor.

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

No environmental impacts are considered significant by the project participants or the host party for this project activity.

However, the project activity will employ various preventive safety measures to counter and prepare for any possible incidents.

Measures taken include:

- Safety drills to prepare personnel for any possible incidents that may occur.
- Safety measures as recommended by solution provider such as flame arrestors, scheduled maintenance etc
- Proper fencing around the project activity to prevent non-qualified personnel from entering the premises.
- Extending the existing emergency response plan to cover the project activity.
- EHS training.
- Preventive signboards and safe working procedures.
- Leakage testing will be performed regularly to prevent any leakages from occurring.

SECTION E. Stakeholders' comments

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

A local Stakeholders' Consultation was held on 16/07/09 in accordance with Gold Standard procedures to gather comments and feedback from stakeholders while in the process of obtaining "Host Country Approval" in Malaysia.

The local session was organized by ULU BASIR Palm Oil Mill and Danish Energy Management at BOP club, Ulu Bernam estate, Bernam, Perak, Malaysia.

The local stakeholders were invited via advertisement in local newspapers (New Straits Times and Bertia Harian), written invitations to local stakeholders and statutory bodies and email invitations to non-governmental organizations.

Mr. Yogaanandh from Danish Energy Management made a project presentation in local Bahasa Malaysia language and collected feedback from stakeholders. The meeting agenda was as follows:

- Opening Speech by ULU BASIR representative
- Introduction to Clean Development Mechanism & Gold Standard by Danish Energy Management
- Presentation of Biogas Projects by Danish Energy Management
- Q & A
- Workshop- Blind Sustainable Development Exercise
- Discussion on Monitoring Sustainable Development
- Conclusion

The following were the questions and answers given during the Q & A session:

No.	Question	Answer
1	Is the project for making money or for protecting the environment?	It is for protecting the environment. There is only a small return from the project since the project will only displace relatively cheap biomass and not expensive fuels.
2	Do you have any plans to sell excess biomass produced electricity to TNB?	The project will promote use of renewable energy. However, at the moment it is not viable and practicable to connect to the electricity grid but it will be in the future.
3	Why don't Annex 1 countries (DK) reduce greenhouse gases in their own countries?	CDM is only a small percentage greenhouse gas reductions. Annex 1 countries (DK) can only make a small percentage of their emission reductions via CDM. The remaining reductions must be made at home or other Annex 1 countries.
4	Is it cheaper to buy CER abroad as compared to making the reductions at home?	For the same amount of money, a country can make a greater impact on the environment and contribute to larger emission reductions via the CDM mechanism. Developing countries may not have access to the same

		technology as Annex 1 countries. Therefore, a project in a developing country may have a larger impact for the same amount of money.
5	Are we rewarding emitters of CO2 via the CDM?	There are very strict rules and regulations to be followed. There is a long process of approval, validation and certification which includes independent consultants and third party inspectors and approvers. The process also includes establishing a baseline and checking for additionality in an effort to avoid rewarding emitters and thereby exploiting the mechanism. It is very difficult to exploit the mechanism due to the thorough checks and procedures implemented in the mechanism.
6	Is UP energy self sufficient now?	Yes. Most palm oil mills (including UP) are self sufficient.

E.2. Summary of the comments received:

The stakeholders raised no major concerns or objections during the consultation. The project is located at the existing compound and wastewater treatment site owned by the mill and would not affect the local community. The project activity as mentioned in the previous section will only have positive effects on sustainable development. Positive effects identified by stakeholders included improving air quality through reduction of odor and cleaner emission as well as wastewater discharge quality and work opportunities.

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

As stated above the stakeholders raised no major concerns or objections. The answers provided by ULU BASIR Palm Oil Mill and Danish Energy Management in relation to impact and compliance issues satisfied the participants. The project received many positive comments from local stakeholders for implementing this CDM project which can bring benefits to the local community.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

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CER Buyer :

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Annex 2

INFORMATION REGARDING PUBLIC FUNDING

Public funding from The Danish Ministry of Climate and Energy and the Royal Danish Embassy, Kuala Lumpur, is involved in this project. Both reaffirm that any funding for the project does not result in diversion of official development assistance and is separate from and is not counted towards the financial obligations of the Party.

Annex 3

BASELINE INFORMATION

Table A3.1 Forecasted FFB and POME production.

Year	FFB Throughput	POME factor	Volume of POME
No.	tons/yr	m^3/ton	m^3/yr
2010	170,000	0.75	127,500
2011	170,000	0.75	127,500
2012	175,000	0.75	131,250
2013	180,000	0.75	135,000
2014	180,000	0.75	135,000
2015	184,000	0.75	138,000
2016	188,000	0.75	141,000
2017	192,000	0.75	144,000
2018	196,000	0.75	147,000
2019	200,000	0.75	150,000
2020	170,000	0.75	127,500

Table A3.2 Anaerobic lagoon measurement campaign.

DATE	COD IN	COD OUT	FLOW	FFB
dd/mm/yy	g/m^3	g/m^3	m^3	tons
01/08/09	75,605	2,722	448	673
02/08/09	63,715	5,484	431.8	588
03/08/09	74,995	3,327	406	574
04/08/09	58,838	2,661	444	598
05/08/09	67,475	4,748	417	521
06/08/09	58,736	3,629	449	662
08/08/09	60,972	2,772	335	486
09/08/09	58,736	3,226	460	662
11/08/09	61,175	2,520	429	600
12/08/09	63,817	3,639	595	665
13/08/09	67,069	7,187	627	814
15/08/09	73,877	6,109	362	462
16/08/09	66,561	2,823	437	506
Averages	65,500	3,900	449	601

Table A3.3 Project site electricity consumption

Year	Source	Consumption (kWh)
2007	Grid	1,133,138
2008	Grid	1,166,080
2009	Grid	847,787
Average	Grid	1,049,002
2007	Diesel	59,150
2008	Diesel	62,995
2009	Diesel	11,665
Average	Diesel	44,603
2007	Biomass	3,482,991
2008	Biomass	3,855,832
2009	Biomass	3,565,893
Average	Biomass	3,634,905

Annex 4

MONITORING INFORMATION

Refer to Section B.7