CLEAN DEVELOPMENT MECHANISM
PROJECT DESIGN DOCUMENT FORM (CDM-PDD)
Version 03 - in effect as of: 28 July 2006

CONTENTS

Annexes

SECTION A. General description of project activity

A.1 Title of the project activity:

Methane Recovery for Onsite Utilisation Project at Desa Kim Loong Palm Oil Mill, Sook, Keningau, Sabah, Malaysia. (Version 1.6 September 04, 2008)

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A.2. Description of the project activity:

The Desa Kim Loong Palm Oil Mill (hereafter referred as 'the Mill), located in Sook, Keningau, Sabah, is currently processing 210,000 tonnes of Fresh Fruit Bunch (FFB) per year. The Mill, which has a maximum throughput of 45 tph (tonnes FFB per hour) ~ approximately 330,000 tonnes FFB per year, is currently under-utilised due to availability of FFB. The annual throughput shall increase with time as the surrounding oil palm plantations mature. In the processing of FFB steam is used for sterilisation and hot water is used for dilution. These, together with the juice squeezed from moisture reduction of empty fruit bunch, produce a wastewater, referred to as Palm Oil Mill Effluent (POME). For every tonne of FFB processed at the Mill, approximately 0.7 m^3 of POME is produced. The POME has high content of organic matter, with an average Chemical Oxygen Demand (COD) of 57,550 mg/litre.

As illustrated in Figure 1, the raw POME is immediately piped from the mill to a de-oiling tank to separate the residue palm oil before it is pumped to a cooling and acidification pond for further treatment. Subsequently, the POME is treated in two open anaerobic tanks where approximately 80% of the organic matter is removed. The tanks are followed by an anaerobic lagoon where 40% of the remaining organic matter is removed. The methane gas formed during the anaerobic conditions in the tanks and open ponds is emitted to the atmosphere. The last polishing of the POME to below the legislated discharge level of 1,000 mg/L Biochemical Oxygen Demand (BOD) is done in aerobic ponds and polishing pond before discharge for land application.

The current heat and power consumption on-site is produced using biomass waste (palm kernel shells, mesocarp fibres and empty fruit bunches) from the Mill with a diesel generator as backup. The use of diesel is required during start up, mal-functioning of biomass boilers or shortage of biomass fuel. The biogas from the biogas plant will be burned together with other biomass residues in the existing biomass boiler.

The CDM project activity aims to reduce the methane emissions from the treatment of POME. The existing open anaerobic tanks will be enclosed and installed with a biogas capture and collection system for utilisation for on-site heat and power generation. The biogas (consisting 65% of methane by volume) captured will be used in the boiler to generate steam and fed into a steam turbine for electricity production for use at the palm oil mill.

The biogas is expected to reduce the diesel consumption with at least 67% compared with the baseline. The biogas will also replace some palm kernel shell from the daily operations. The surplus of shell generated in this way will be used for power production for staff quarters when mill is not running. This will lead to a temporary storage of shells at the site, but storage time only expected to be 1-2 months.

With higher organic removal rates achieved in the enclosed digester tanks, the subsequent anaerobic lagoon will be closed after the implementation of the project activity. The treated POME will, therefore, be channelled into the subsequent aerobic and polishing lagoons for further treatment before the final

discharge is used for land application. The aerobic lagoons will remove the remaining organic materials in the wastewater under aerobic condition and methane emission is expected to be insignificant.
The project activity will contribute to sustainable development by:

- Reducing air pollution from the open tanks/ponds in the anaerobic treatment of the POME. The emissions to air include methane, volatile fatty acids and hydrogen sulphide (H_2S). These emissions contribute to global climate change, acid rain and offensive smell in the local area;
- Reducing water pollution from the POME as the new biogas system will provide better controlled and more efficient process for removal of the organic content of the POME; and
- Increase the amount of renewable energy available by using the biogas as energy source in existing boilers.

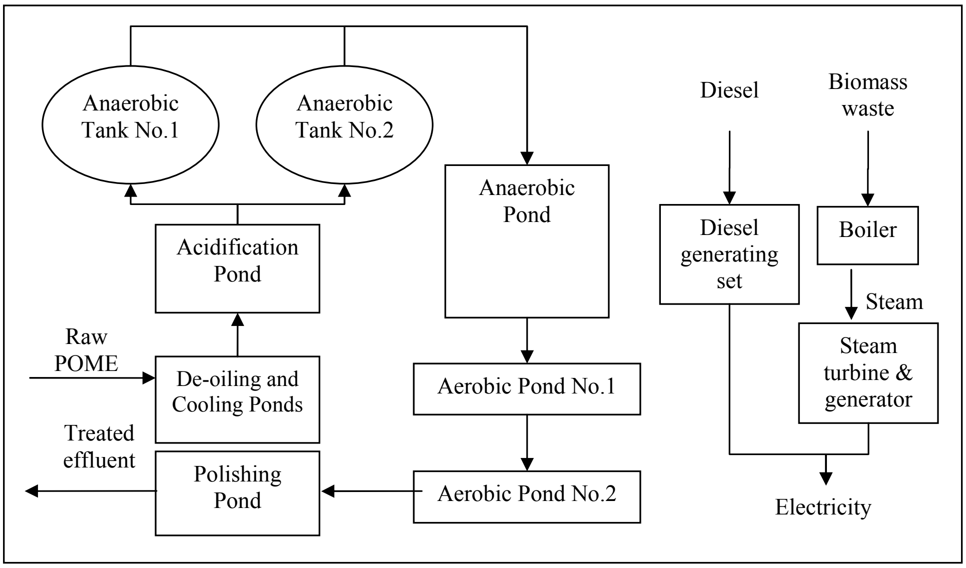

Figure 1: The Mill's current process of POME treatment and on site steam and power generation

The overall timeline of project implementations will be as follows:

- Date of signing an ERPA with the buyer 07-12 - 2006
- Date of Board approval starting the implementation of the project: 18-12-2006
- Stakeholder meeting: 08-01-2007
- On site validation of PDD: 12-02-2007
- Date for start of construction at site: 01-03-2007
- Date of expected commissioning: 01-07-2007
- Date of commercial operation: 01-09-2007

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: Kim Loong Power Sdn. Bhd	No
Germany	swb Erzeugung GmbH & Co. KG	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 project activity:

A.4.1. Location of the project activity:

A.4.1.1. Host Party(ies):

Malaysia

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

Sabah

A.4.1.3. City/Town/Community etc:

Sook, Keningau

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

The project activity will be implemented at Desa Kim Loong Palm Oil Mill, Lot CL 135345069. Km 3, Jalan Karamotai, 35 KM Off Jalan Nabawan. Sook.

The site location is shown in Figure 2 below.

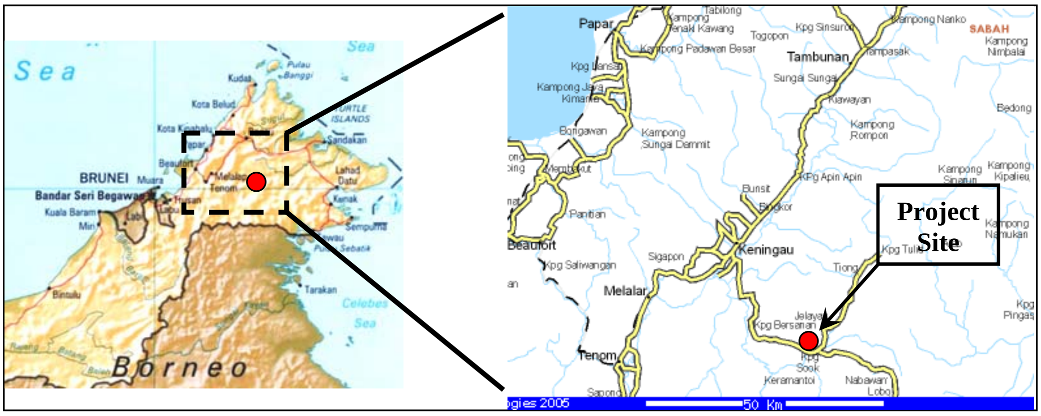

Figure 2: Location map of the project site

A.4.2. Category(ies) of project activity:

Sectoral Scope 13: Waste handling and disposal category.

A.4.3. Technology to be employed by the project activity:

The project activity will enclose and convert the existing open anaerobic tanks into enclosed anaerobic digester tanks. This closed anaerobic digester technology is well-proven globally for managing high organic waste and commonly referred to as biogas or anaerobic digestion technologies.

The two existing tanks will be enforced with a 3 mm steel plate and a new stainless steel cover plate to contain the biogas and prevent leakage. The tanks will further be furnished with appropriately spaced inlets for POME at the bottom to secure a good mixing through the upwards flow in the tank. The organic matters in the wastewater are decomposed under a number of anaerobic processes. The decomposition process leads to the formation of biogas containing CH_4 and CO_2. For a well designed and operated closed digester, the COD removal efficiency would be in the range of 90-95% (Borja *et al* 1996; DOE 1999) while biogas containing CH_4 concentration of 60-65% (Ma 2002; Yeoh 2004a) can be achieved.

An extra tank will be constructed to secure the necessary capacity of the biogas treatment and to provide a back up tank when one of the tanks are out for maintenance.

During the construction and operation of the biogas system all necessary precautions will be taken to prevent leakage. (See more detail in section B3)

Figure 2 shows the process of POME treatment and on site steam and power generation with the implementation of the project activity. While the digested POME is channelled into aerobic ponds for further treatment, the captured biogas is pumped through a pipeline delivery system to the boiler for generating steam. The steam will be fed into a steam turbine for electricity production for use at the palm oil mill, a new kernel crushing plant and other downstream projects.

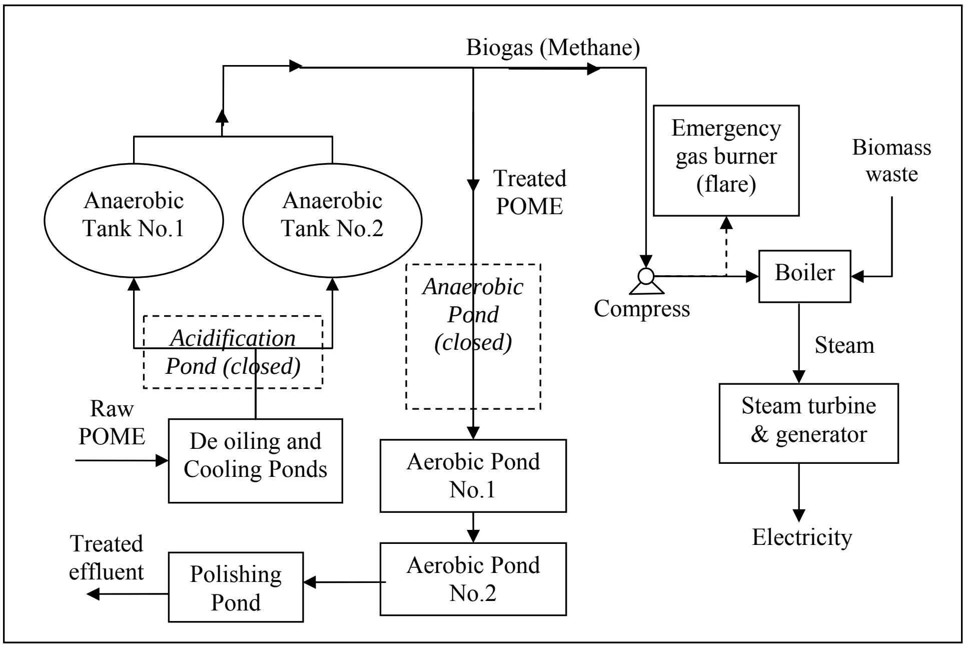

Figure 3: The process of POME treatment and on site steam and power generation after the implementation of the project activity

There is hardly any energy consumption of the project as it only includes pumping of the POME (which is also done in the baseline) and compression of the biogas before it is send to the boiler. The minimal project energy consumption is supplied from the biomass fired boiler and has thus no emissions of greenhouse gasses.

The biogas produced will be burned in the existing Vickers Hoskins water tube boiler. The boiler was installed in 2003 and delivers up to 5000 kg steam/hour to the mill. Part of the steam is used to run a steam turbine producing electricity to the plant and surrounding staff quarters. The main fuel for the boiler will continue to be palm kernel shells and mezocarp fibre – waste products from the palm oil mill.

The palm oil mill also has a diesel generator used to produce power when the boiler is not operating.

The biogas is expected to reduce the diesel consumption with at least 67% compared with the baseline. The biogas will also replace some palm kernel shell from the daily operations. The surplus of shell generated in this way will be used for power production for staff quarters when mill is not running. This will lead to a temporary storage of shells at the site, but storage time only expected to be 1-2 months.

Training shall be conducted to all the personnel involved in the project. For the engineer and technicians, basic theory and operational procedures of anaerobic digester shall be conducted. The basic theory shall be based on the “Effluent Treatment (Anaerobic Digestion & Biogas Utilization)”, Diploma in Palm Oil Milling Technology & Management: Semester I, Palm Oil Research Institute of Malaysia. For the initial period, hands-on training shall be given to the engineer and technicians on the operational aspects. Training shall be recorded and operational procedures for engineers and technicians will be developed.

The performance of the biogas plant will be monitored continuously for the amount and the quality of the biogas generated. This gives a possibility for correction of any malfunction on an hour to hour basis.

The specific biogas technology employed in the project is developed in Malaysia based on global and local experience with biogas. Since Malaysia is the leading country in the world in the area of palm oil it is not surprising that biogas technology for the use in this sector is adapted locally. The use of biogas technology is a clear improvement of the existing open pond system in a number of ways:

- The process will be better controlled and thus give more consistent reduction in organic content of the discharge from the palm oil mill
- The air pollution from the waste water treatment is reduced, benefiting to both the local environment and the global climate
- The biogas will be used for energy purposes and thus promotes renewable energy in Malaysia

Finally, allowing the local adaptation of the biogas technology leads to significant cost reductions necessary for the spread of the technology in the palm oil sector. The biogas plants developed in industrial countries are typically twice as expensive as locally manufactured plant. This price differential makes the use of biogas prohibitive in the palm oil industry – even if CERs can be claimed for the reductions in methane emissions.

The development of a local biogas technology is thus a necessity for a long term sustainable implementation of biogas in the palm oil sector. It will also generate jobs in Malaysia to develop such equipment. The local development of the technology also secures the availability of skills for the operation and maintenance of the plant.

The monitoring technology will be provided by Opsis from Sweden. The Opsis LD 500 Laser Diode Gas Analyser allows continuous monitoring of the methane gas produced in the biogas plant. This represents transfer of state of the art monitoring technology from Sweden to Malaysia.

In summary, the local adaptation of a globally available technology can be seen as the final stage of technology transfer. (For reference see for instance the IPCC special report: "Methodological and technological issues in Technology Transfer").

A.4.4 Estimated amount of emission reductions over the chosen crediting period:

The total estimated emission reduction is estimated to be **383,401** tCO_2eq over the entire crediting period. The maximum emission reductions can be achieved if the palm oil mill used to its maximum capacity will be 486,537 t CO_2eq. The actual amount of emission reductions will be calculated ex post based on actual production.

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Year	Annual estimation of emission reductions in tonnes of CO_2e
2008 (5 months)	14,131
2009	37,200
2010	38,685
2011	38,685
2012	38,685
2013	38,685

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2014	38,685	Deleted: 39,264
2015	38,685	Deleted: 39,264
2016	38,685	Deleted: 39,264
2017	38,685	Deleted: 39,264
2018 (7 months)	22,593	Deleted: 22,931
Total estimated reductions (tonnes of CO_2e)	383,401	Deleted: 389,147
Total number of crediting years	10	Deleted: 10
Annual average over the crediting period of estimated reduction (tonnes of CO_2e)	38,340	Deleted: 38,915

A.4.5. Public funding of the project activity:

There is no Public Funding involved in this 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 project activity:

1. AM0022: Avoided Wastewater and On-site Energy Use Emissions in the Industrial Sector (Version 4, 22 December 2006);
2. Tool for the demonstration and assessment of additionality (Version 03,16 February 2007).
3. Tool to determine project emissions from flaring gases containing methane (Annex 13, EB 28, 15 December 2006)

B.2 Justification of the choice of the methodology and why it is applicable to the project activity:

This methodology is applicable to the project activity as anaerobic treatment system is introduced in the existing treatment of POME. The existing anaerobic treatment process does not have any methane capturing facility. Recovery of biogas from the anaerobic digestion of the POME, which is one of the industrial wastewater sources in Malaysia, for utilisation in on-site heat and power generation, will mitigate the methane emission from the existing treatment of POME.

Comparison of the project activity to the applicability conditions of AM0022 is shown in Table 1:

Table 1: Comparison of the project to the applicability conditions in AM0022

Applicability Criteria of AM0022	Project conditions

Applicability Criteria of AM0022	Project conditions
The project is implemented in existing lagoon-based industrial waste water treatment facilities for wastewater with high organic loading.	This project involves POME which is a high organic content wastewater (COD of POME entering the digester tanks ranges 53,000 to 65,000 mg/L) treated in open anaerobic digester tanks and lagoons.
The organic wastewater contains simple organic compounds (mono-saccharides). If the methodology is used for waste water containing materials not akin to simple sugars a CH_4 emissions factor different from 0.21 kg CH_4/kgCOD can be estimated and applied.	The POME consists of more complex organic compounds (e.g. lipids) and thus expected to yield a higher CH_4 emissions factor per kg COD digested. A study[1] concerning methane formation in-situ in POME ponds in a palm oil mill and thus highly relevant for the current project collected daily COD measurements and continuous methane measurement for a year as a basis to calculate the relation between COD removed and methane production: "*methane emission from anaerobic ponds A and B were 0.223 and 0.247 kg of methane per kilogram of COD removed.*" These numbers are 6% and 18% higher than the default value used – and the default value used can thus be regarded as conservative. To ensure conservativeness, the 0.21 kg CH_4/kgCOD is used in this project.
The methodology is applicable only to the improvement of existing wastewater treatment facilities. It is not applicable for new facilities to be built or new build to extend current site capacity.	The project activity will be implemented on the existing wastewater treatment system, i.e. closing the anaerobic tanks that are already in placed. Although the Mill's annual throughput is expected to increase over the next few years, the existing wastewater treatment facility is sufficient for the additional POME generated.
It can be shown that the baseline is the continuation of a current lagoon system for managing waste water. In particular, the current lagoon based system is in full compliance with existing rules and Regulations.	The baseline is the continuation of the current wastewater treatment system, as documented in Section B.4 below. The past three years records of the effluent discharged from the current system complied with standards set by the Malaysian Department of Environment (DOE) under the Environment Quality (Prescribed Premises)(Crude Palm Oil) Regulations, 1977.
The depth of the anaerobic lagoons should be at least 1m.	The anaerobic digester tanks are around 12 m in height with a depth of at least 11.75 m. The open anaerobic lagoons are 5.95 m in depth.
The temperature of the wastewater in the anaerobic lagoons is always at least 15˚C.	The temperature of the wastewater fed into the open tanks is about 43˚C and the temperature at the outlet is measured to be around 35˚C. The annual mean ambient temperature in Malaysia is between 26-28˚C (MOSTE 2000). Therefore the temperature of the wastewater will exceed 15˚C.

[1] Shahrakbah Yacob et al (2005) Baseline study of methane emission from anaerobic ponds of palm oil mill effluent treatment. Science of the Total Environment p 8

Applicability Criteria of AM0022	Project conditions
In the project, the biogas recovered from the anaerobic treatment system is flared and/or used on-site for heat and/or power generation, surplus biogas is flared.	The biogas recovered will be utilised in on-site heat and power generation. The biogas will only be flared in emergency situations when the boiler is not able to utilise the available gas.
Heat and electricity needs per unit input of the treatment facility remain largely unchanged before and after the project.	No heating is needed for the closed tank digesters as the system will be operated at mesophilic conditions. The energy for feeding POME in the open tanks (before project) is not expected to differ significantly to the energy requirement for up-flow feeding of POME to the closed tank digesters (after project). The only additional electricity needed is relatively small, for the compressors and a gas pump. Therefore, there will be no major change to the heat and electricity needs in the treatment facility before and the project.
Data requirements as laid out in the related monitoring methodology are fulfilled. In particular, organic materials flow into and out of the considered lagoon based treatment system and the contribution of different removal process can be quantified (measured or estimated)	All the data specified in the monitoring methodology can be measured or estimated. Clear and specific sampling locations for POME inlet and outlet sampling have been identified.

B.3. Description of the sources and gases included in the project boundary

Sources and types of GHG emissions in baseline and project scenarios are summarised in Table 2.

Table 2: Sources and types of GHG emissions in baseline and project scenarios

	Source	Gas	Included?	Justification/Explanation
Baseline	POME treatment	CO_2	No	Emissions originating from biogenic sources are considered carbon-neutral
		CH_4	Yes	Emissions from both the open digester tanks and anaerobic lagoon. This is main emission in the baseline
		N_2O	No	Excluded for simplification. This is a conservative assumption
	Biomass boiler	CO_2	No	Emissions originating from biogenic sources are considered carbon-neutral
		CH_4	No	Methane emissions from the burning of biomass are expected to be small. This is a conservative assumption.
		N_2O	No	Excluded for simplification. This is a conservative assumption
	Fossil diesel	CO_2	Yes	The use of fossil diesel is required during start up,

	back up			mal-functioning of biomass boilers or shortage of biomass fuel. The emissions are small and are expected to be similar or higher than in the project case
		CH_4	No	Excluded for simplification. This is a conservative assumption
		N_2O	No	Excluded for simplification. This is a conservative assumption
Project Activity	POME treatment	CO_2	No	Emissions originating from biogenic sources are considered carbon-neutral
		CH_4	No	Fugitive emissions from the enclosed tank digesters and the piping of the biogas are expected to be negligible. See below (Note: The anaerobic lagoon will be removed and the effluent wastewater from the enclosed tanks will be channelled directly into the aerobic lagoons. The level of fugitive emissions from the aerobic ponds are not expected to change from the baseline)
		N_2O	No	Excluded for simplification. Expected to be minimal
	Biomass boiler including biogas combustion	CO_2	No	Emissions originating from biogenic sources are considered carbon-neutral
		CH_4	Yes	Methane emissions from the burning of the biogas in the boiler is expected to be minimal as the long residence time in the boiler (compared to a gas engine) will secure full combustion of the methane.
		N_2O	No	Excluded for simplification. Expected to be minimal
	Fossil diesel for back up	CO_2	Yes	Emissions are expected to be similar of lower than the baseline emissions
		CH_4	No	Excluded for simplification. Expected to be minimal
		N_2O	No	Excluded for simplification. Expected to be minimal
	Flare emissions	CO_2	No	Emissions originating from biogenic sources are considered carbon-neutral
		CH_4	Yes	Emissions are expected to be minimal since the flare will only be used in emergency situations
		N_2O	No	Excluded for simplification. Expected to be minimal

There are not expected to be any emissions fugitive emissions from the biogas plant. This assessment is supported by the following statement from IPCC 2006: *Where technical standards for biogas plants ensure that unintentional CH4 emissions are flared, CH4 emissions are likely to be close to zero*[2]. This claim is further substantiated through the following arguments:

[2] IPCC 2006: Volume 5, Chapter 4 p 4

1) Possible methane formation in the palm oil mill from formation of the raw POME (Palm Oil Mill Effluent) to entry into the biogas digester (upsteam methane formation) is out side the project boundary as the CODin used for calculation of the methane formation potential is measured at the entry point to the digester. The upstream methane formation is expected to be unchanged (or reduced) compared to the baseline situation. The reduction compared to the baseline could emerge since the acidification pond is closed (see figure 5 p 24 in the PDD).

2) The design and construction of the anaerobic digester plant will comply with the national Technical Specifications and Standards, basically referencing to the British Standard Specifications and the 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.

3) The two existing tanks will be enforced with a 3 mm steel plate and a new stainless steel cover plate to contain the biogas and prevent leakage. The fabrication and installation of the digester tanks will follow strictly the Technical Specifications and Standards where defect-free welding will be ensured. The completed tanks, with the pressure gauges installed, shall be subjected to hydrostatic test and gas-leakage test before commissioning. For the gas-leakage test both the two existing tanks and the new tank will be tested at an expected maximum internal gas pressure of up to 300 mm water column (approximately 3.0 kPa). Any welding defects shall be immediately rectified. Due to the relatively low pressure of the biogas in the digester tanks, the engineering design and fabrication will ensure a leak-free system for the containment and collection of the biogas generated during operation.

4) The main gas pipeline transporting biogas from anaerobic digesters to the boiler will be short (less than 2 km) and is to be constructed by using stainless steel 304 schedule 10S pipes. The welded pipeline shall be installed with two pressure gauges, one at the beginning and one towards the end of the main pipeline. One stainless steel valve shall be installed before the first pressure gauge whereas another stainless steel valve shall be installed after the other pressure gauge.

After construction and installation, the main pipeline shall be pressure tested at 10 kg/cm^2 and check for leaks along the pipeline. In any welding defects causing the leaks are detected they shall be rectified. After rectifying the leakages, the main pipeline must be pressure tested again. The process shall be repeated until no leak along the pipeline is detectable.

A leakage report will be prepared and will be available during the verification by DOE.

5) Along other gas pipelines similar procedure shall be used except that these very short pipelines shall not be installed with pressure gauges. These pipelines include the short sections beyond the main pipelines.

Leakage monitoring as described above will be conducted every year and results of the leakage report will be made available to the DOE during verification.

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B.4. Description of how the baseline scenario is identified and description of the identified baseline scenario:

The baseline determination consists of a six-step process in order to define the baseline and to demonstrate that the continuation of current practices (existing lagoon based waste water treatment system without biogas use) is the baseline:

Step 1: Listing a range of potential baseline options

Five options are identified as plausible alternatives to assess in relation to determining the baseline:

- *Option 1: Direct release of POME to nearby water body*
  This option is not used in Malaysia as the high organic content of the POME would be very damaging to the water ecosystems and would disturb downstream use of the water.

- *Option 2: Installation of new treatment system (activated sludge or filter bed type treatment)*
  There has been no or very little experience in the palm oil industry with alternative, aerobic treatment systems. The investment costs will be significantly higher than the conventional pond systems and will possibly also encounter technical difficulties in making such systems function with the POME. Since the existing system can fulfil the environmental constraint there has also been no driving factor for such solutions.

- *Option 3: Continuation of the current situation (business as usual)*
  The present system of open tanks/ponds is the most common wastewater treatment system for palm oil mills in Malaysia, whereby 85% of the palm oil mills use open ponds. A further 5-10% use open tanks, while the rest use composting and others (Eco-Ideal 2004; Yeoh 2004a). The treated POME can be applied either to land (with a BOD [30^0C for 3 days] requirement of 5,000 mg/L) or directed to water ways (with a BOD requirement of 100 mg/L) (ILBS 2004; Shamsudin 2006). The anaerobic tanks/ponds are necessary in both cases to reduce the BOD level from around 25,000 mg/L in the raw POME. For discharge to water ways it is customary – as in the case of the Mill – to have a final polishing with an aerobic system to remove the last 5% of the organic matter.

- *Option 4: The proposed biogas system not undertaken as a CDM project activity*
  There is very limited experience in Malaysia with biogas system for POME (Eco-Ideal 2004) and a number of demonstration projects have not been perceived successful. There have been difficulties with the performance of the biogas production and with corrosion in gas engines using the biogas. This gives reluctance in the palm oil industry to enter into biogas projects. At the same time the investment cost are significant and the savings in energy costs from the generation of biogas are not in itself enough to make the investments attractive. In most cases only biomass waste is replaced and this has a low value.

- *Option 5: Composting of empty fruit bunches (EFB) and POME*
  A new technology developed in recent years is composting of EFB and POME. Composting will reduce both waste stream and is thus an interesting alternative to the open ponds. The experiences with open field composting are mixed (Chua *et al*. 2006; Mohd. Razib 2006; Radhakrishnan 2006; Suki and Wok 2006). There are significant technological uncertainties. The composting will also require significant extra investment cost. In a case without CDM there will thus be significant barriers for the composting solution

Step 2: Select the barriers from the range of potential barriers that can be demonstrated to be significant in the context of the particular project under consideration

The following table summarises the main types of barriers for project implementation and their significance:

Potential Barriers	Significance
Legal	Absolute
Technical	Most Significant
Financial	Most Significant
Social	Significant
Business Culture	Significant

The legal barrier is an absolute barrier in the sense that illegal options can not be the baseline. Therefore no further assessment of this option will be carried out. Beyond the legal barrier, the technical and financial barriers are evaluated as the most significant. Existing and perceived technical and financial barriers can lead to cultural barriers. In many cases, there may be remaining barriers against change in "common practice" even if the technical and financial barriers have been overcome.

Step 3: Score the barrier

Score for each barrier is done by addressing the questions as set out in the Table 3.

Table 3: Barrier Test Framework

Plausible Baseline Option **Barrier Tested**	**Direct release**	**New system**	**Business as usual**	**Biogas**	**Compost**
Legal					
Does the practice violate any host country laws or regulations or is it not in compliance with them?	Y	N	N	N	N
Technical					
Is this technology option currently difficult to purchase through local equipment suppliers?	NA	Y	N	N	N
Are skills and labour to operate and maintain this technology in the country insufficient?	NA	Y	N	Y	Y
Is this technology outside common practice in similar industries in the country?	NA	Y	N	Y	Y
Is performance certainty not guaranteed with tolerance limits?	NA	N	N	N	N
Is there real or perceived technology risk associated with the technology?	NA	Y	N	Y	Y
Financial					
Is the technology intervention financially less attractive in comparison to other technologies (taking into account potential subsidies, soft loans or tax windows available)?	NA	Y	N	Y	Y
Is equity participation difficult to find locally?	NA	Y	N	Y	Y
Is equity participation difficult to find internationally?	NA	NA	NA	NA	NA
Are site owners/project beneficiaries carrying any risk?	NA	Y	N	Y	Y

Social					
Is the understanding of the technology low in the host country/industry considered?	NA	Y	N	Y	Y
Business culture					
Is there a reluctance to change to alternative management practices in the absence of regulation?	NA	Y	N	Y	Y
Others					
Is there lack of experience in applying the technologies?	NA	Y	N	Y	Y

*** Y: Barrier exists N: Barrier does not exist NA: Question is not relevant*

<u>*Option 1: Direct release of POME to nearby water body*</u>
It is not legal in Malaysia to discharge POME directly into water bodies in Malaysia. This means that there is an absolute barrier for this option – and that all the other barriers become irrelevant. This is not least true since the Department of Environment is enforcing this legislation.

<u>*Option 2: Installation of new treatment system (activated sludge or filter bed type treatment)*</u>
Installation of new aerobic treatment systems will be able to fulfil the legal requirements of the Malaysian government. There is no legal barrier to this solution. Theoretically the technology would be able to comply with the discharge limits for POME, so there is no barrier regarding complying with emission standards.

There are however serious technological barriers and as it has not been demonstrated in full scale for palm oil mills. The technology is mainly marketed towards industries with smaller volumes of sewage. There are no local suppliers of such technology able to handle palm oil waste water. This also means that there is no local labour available capable of establishing and maintaining aerobic sewage treatment system for POME. On aggregate the technology is perceived unsuitable for the needs of the palm oil sector.

Beyond the technological barriers the aerobic solution are also more expensive than the conventional systems. This leads in turn to difficulties in finding local equity participation for implementing such a project. There is no tradition for involving foreign equity in projects like biogas in the palm oil sector. Therefore is the barrier to foreign participation marked as not applicable.

There is a general lack of experience with the technology since it has never been implemented in Malaysia in palm oil sector. That also reinforces the reluctance among management to enter into new technologies. Not least since the costs is higher than for competing technological solutions

<u>*Option 3: Continuation of the current situation (business as usual*</u>)
Continuation of the current open pond systems comply with Malaysian legislation, so there is no legal barrier to the business as usual. The anaerobic tank and open pond systems are well proven for POME and can readily be established by local technology suppliers. There is also abundant local labour available with experience in this technology. More than 95% of all palm oil millers are using anaerobic systems and this is thus the mainstream technology. The technological risks are minimal and well known in the industry.

The technology is the most financially attractive since it has low establishment and running costs and it is thus not difficult to find local equity for investment in the ponding systems. The ponding system also fit the generally low technology level in the palm oil mills and thus fit well with the frame of mind for management.

Option 4: The proposed biogas system not undertaken as a CDM project activity
The biogas system will be able to comply with the national legislation, so there is no legal barrier to the solution. There are a number of local suppliers claiming to be able to supply biogas technology for treatment of POME. There are however only very limited experience with the biogas technology for treatment of POME and there are clear (perceived) barriers to utilising biogas. The barriers include uncertainty regarding the performance of the biogas digester, the use of the biogas (possible corrosion risks) and the costs of implementation.

The financial costs of implementing biogas solutions are significantly higher than for the business as usual and the investment is only attractive when the income from sale of CERs is included in the cash flow. Therefore it is also difficult find local investors for biogas plant in Malaysia.
There is also in the palm oil sector a general reluctance to invest in non-core activities if it not required by law. This is partly related to the fact that there are a lot of attractive, competing investments in the sector.

Option 5: Composting of empty fruit bunches (EFB) and POME
Composting of EFB and POME is a new technology that is being introduced in the latest years. This technology allows complying with the effluent standards by using the POME as part of a composting process.

There are a few local technology suppliers for composting, but experiences are mixed. There are operational problems to make the process work, issues with handling of the large amounts of rain water in a tropical country like Malaysia and issues with the use of compost. The compost solution is also requiring a lot of space and work power. In general the compost solution is most relevant for palm oil mills where there the miller also have plantations near the mill for application of the compost – and in cases where there is no need for the extra energy from the biogas for downstream activities. But still there will often be the need for income from CDM to make the composting attractive.

There are higher investment costs for compost than for the ponding systems and this combined with the technological risks makes it difficult to find local investors in the composting technology. The experience is limited with composting of palm oil wastes in Malaysia and thus also the qualified staff that can implement such projects. Composting is not relevant to Kim Loong as they do not have plantations that can use the compost.

Step 4: Compare, through assessment of the barrier results, which is the most plausible option and determine whether, on balance, it can be shown that particular barriers drive a particular baseline option

After assessing the barrier results, the most plausible option is Option 3 (business as usual), where least barriers are identified. Legal is an absolute barrier. Hence Option 1 cannot be considered because it violates the host country's law stating that POME must be treated to certain acceptable quality before being released to water bodies. Options 2, 4 and 5 are not economically attractive as additional construction, operational and maintenance costs are required. In addition, technical barriers exist where the less successful operation examples have been demonstrated. This leads again to a negative perception among management and investors against these technologies.

Step 5: Investment analysis

In situation whereby more than one baseline option results from the barrier analysis in steps 2, 3 and 4, the financial viability of each of these options should be assessed as described in Step 2 – Investment

Analysis of the *Tool for the Demonstration and Assessment of Additionality (Version 3)* to differentiate between options and determine the most likely baseline scenario. In this case, however, only one option has been found to be the most plausible, the financial analysis is not needed for comparison purposes. A financial evaluation of the main alternative is conducted as part of the additionality argument below.

Step 6: Conclusion

The assessment of the different alternatives can be summarised as follows:

- *Option 1: Direct release of POME to nearby water body*
  Direct discharge into water ways is prohibited under the Malaysian law and thus not a possible alternative.

- *Option 2: Installation of new treatment system (activated sludge or filter bed type treatment)*
  Aerobic waste water treatment faces both technical and financial barriers that will prevent it from being implemented.

- *Option 3: Continuation of the current situation (business as usual)*
  Business as usual is the least costly solution as it does not include investment cost. At the same time this solution fulfils legal requirements and the technical properties are known. Thus this is also the least risky solution.

- *Option 4: The proposed biogas system not undertaken as a CDM project activity*
  Biogas system has significant technical and financial barriers as it requires additional investments and involves a technological risk that would demand extra financial attractiveness to overcome the decision barriers in the management.

- *Option 5: Composting of empty fruit bunches (EFB) and POME*
  Composting faces both technical and financial barriers that will prevent it from being implemented.

The existing POME treatment system, combining open anaerobic digester tanks and lagoons followed by aerated ponds, complies with the stipulated effluent discharge standards. Open digester tanks and lagoons are the most common and standard practices in palm oil mills in Malaysia (Abdul Latif *et al* 2003; Eco-Ideal 2004; Shirai *et al* 2003; Yeoh 2004b). This method of waste treatment is accepted by the Department of Environment, Malaysia as it meets the effluent discharge standards. The current practice (business as usual) using open tanks and lagoons were reported to be able to remove more than 95% of organic pollutant (Ma *et al* 1993). Thus, there exists no legal requirement or any other motivation factors to implement options which will require additional investments.

Malaysia has a scheme to promote renewable energy, the Small Renewable Energy Project (SREP) programme has been in place since 2000. This scheme addresses only projects with an aim to deliver power to the grid and is thus not relevant for the project at hand, where the generated energy will be used on site. Even beyond this point the SREP programme has not been successful, with only 12 MW installed from two projects in the five year period 2000-2005 (EPU 2006). It can thus be concluded safely that the Malaysian energy policy has not been able to provide incentives that would have made the proposed biogas project a baseline.

In conclusion continuation of the existing open pond system is the most likely scenario without CDM since it has the lowest investment costs (none) and the lowest technological risk (as the performance is know).

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 CDM project activity (assessment and demonstration of additionality):

This section describes how the emissions are reduced below those that would have occurred in the absence of the project activity using the "Tool for the demonstration and assessment of additionality (version 03)" to define the baseline scenario and the project activity.

Starting date

The start date of the project was March 01, 2007 when the work started at the site. Before that date CDM financing had been had been almost fully secured as can be documented by the following line of events:

A CDM consultant was engaged in March 2006 and negotiations with the buyer on an ERPA started in May 2006. The ERPA was signed on 07 December 2006 immediately before the Board of the Desa Kim Loong Palm Oil Mill gave the final consent to start the work on the biogas plant on 18 December 2006.

The stakeholder meeting in relation to the CDM project was held on January 08, 2007 and site validation of the PDD was conducted by TUV SUED on February 12 2007.

Thus CDM was clearly taken into account before the start date of the project.

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

Sub-step 1a. Define alternatives to the project activity:

In accordance to the additionality tool and as elaborated in Step 1 in the above Baseline Determination, there are 5 plausible alternatives as follows:

- Alternative 1: Direct release of POME to nearby water body
- Alternative 2: Installation of new treatment system (activated sludge or filter bed type treatment)
- Alternative 3: Continuation of the current situation (business as usual)
- Alternative 4: The proposed biogas system not undertaken as a CDM project activity
- Alternative 5: Composting of empty fruit bunches (EFB) and POME

Sub-step 1b. Consistency with mandatory laws and regulations:

In Malaysia all mills processing of oil palm fresh fruit bunches into crude palm oil, whether to an intermediate or final products, are licensed as prescribed premises under the Malaysian Environmental Quality (Prescribed Premises)(Crude Palm Oil) Regulations, 1977 (ILBS 2004). The POME, as an extremely polluting effluent with high organic content, is legally regulated to ensure the discharge will not pollute the receiving environment. No discharge of effluent from the mills shall be allowed without license from the Regulations. Where such discharge is licensed, the effluents shall not exceed the level of parameters governed into a watercourse or onto land. The Regulations, however, do not specify the treatment technologies or requirement.

Therefore, except for Alternative 1, all other Alternatives are not restricted by the Regulations.

Step 2: Investment analysis

The Baseline Determination exercise above has shown that there is only one option found to be the most plausible, i.e. the Alternative 3: Continuation of the current situation (business as usual). Financial analysis for assessing the financial viability of different options is not needed for comparison purposes. Therefore, a financial evaluation of the main alternative is conducted in the following sub-steps.

Sub-step 2a. Determine appropriate analysis method
As the project has additional source of revenue (saved fuel costs) compared with the baseline, the simple investment analysis can not be used and since there is only one alternative in the financial analysis the investment comparison analysis is not relevant. The remaining method is the Investment Benchmark Analysis.

Sub-step 2b. – Option III: Apply benchmark analysis
The palm oil sector is generally very profitable. There are a large number of profitable investments to be made in the sector both upstream (in plantations and palm oil mills) and downstream (in processing of crude palm oil to more refined products including vitamins, nutraceuticals, functional foods and bio diesel). In the internal comparison of investment options the Internal Rate of Return (IRR)[3] is often used as benchmark; hence the analysis below will apply IRR as the financial indicator.

The abundance of attractive investment options means that the expectation for IRR in the projects is usually high compared to other sectors. Kim Loong Power uses a 15% IRR benchmark to evaluate their investments[4]. This benchmark is used for similar investments in the company and has thus also been applied for the Kota Tinggi Biogas projects (registered as CDM project no. 867).

The benchmark of 15% is relevant for the palm oil sector. This supported by a study by Eco-Ideal (2004), where an IRR of 15% is considered as a reasonable benchmark for the palm oil sector in Malaysia. The benchmark is further supported by a study by CIMB Bank[5] comparing the return on capital in the palm oil plantation sector. The companies mentioned are the main integrated palm oil companies in Malaysia and have both plantations and palm oil mills in their portfolio. The simple average Return on Equity in these companies has been 11.2% in 2006 and expected to be 11.9% in 2007 according to the table on p 2 of the report. If a weighted average is calculated – taking into account the relative Market Capitalisation of the companies – the Return of Equity is 13.1% and 14.0% for 2006 and 2007 respectively. In order to achieve such level of returns as average for the whole group individual projects will need to have a slightly higher benchmark. This shows that the 15% return benchmark is well in line with the general investment opportunities in the palm oil sector.

Sub-step 2c. Calculation and comparison of financial indicators
The major assumptions for the economic evaluation are presented Table 4 and the detailed assumptions in Annex 3.

Table 4 – Major assumptions for financial analysis

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[3] The IRR refereed to is the project IRR (as opposed to the equity IRR)

[4] See Board resolution of 06/12/2006

[5] CIMB Investment Research Report, 23 November, 2006: Plantation Sector

Price of carbon (EURO € /tCO_2e) – net brokerage fees		11
Exchange rate RM/EURO €		4.6
Project development costs (RM) • Modifications of the two open anaerobic tanks into enclosed ones, an overflow tank, pumps, compressors, waste fuel burners, flame arrestors, lightning arrestor, piping and fittings, a new boiler with dual fuel burner, steam turbine, electrical installation, gas sampling and monitoring equipments, housing structures for operation control room.		5,300,000
Estimated annual operating costs (RM)	Repair and maintenance	200,000
	Other administration expenses (travel, stationary. Etc)	42,000
	Salaries and wages	150,000
	Consultancy fees (total)	400,000
	Land rental (total)	120,000
	Telecommunications payment	2,000
	Audit fee, secretary fee and others	50,000
	Utilities payment	20,000
Estimated revenues from biogas (RM) per year at full production		781,039

The value of the biogas was included in the calculation in two ways:

- The value of replacement of 69% of the diesel consumption from the baseline is valued by the current pump price for diesel of 1.53 RM/litre
- The remaining biogas is valued with the estimated conservative value of the biomass of 8.3 RM/GJ of energy. The full explanation of who this value is derived can be found at the end of Annex 3.

The project will be financed in full by the mother company of Kim Loong Power, Kim Loong Resources Berhad. In this way the project is effectively 100% equity financed. Making the IRR calculated both the project IRR and the equity IRR.

The project IRR without financing incentives from CDM will be negative for both 7 years and 10 years of financial projection. However, with CDM financing, the IRR can be increased to 24.2 % and 28.6 % for 7 years and 10 years respectively.

Sub-step 2d. Sensitivity analysis:
The table below shows a sensitivity analysis for the major parameters in the calculation of the IRR. Focus has been on identifying the parameters of most relevance for the "without CDM" situation. The sensitivities illustrated are the period of financial projection – from 7 to 10 years. This sensitivity is shown in Table 5 for the two other calculations "reduced capital cost by 25%" and "Increased value of biomass by 50%".

Table 5: Sensitivity analysis of the project IRR

Scenario	**IRR w/o CDM**		**IRR w CDM**	
	7 years	**10 years**	**7 years**	**10 years**
Basis assumptions	-10.7%	-2.5%	24.2%	28.6%
Capital cost – 25%	-5.4%	2.1%	33.5%	37.2%
Value of biomass (+ 50%)	0.4%	7.4%	29.7%	33.7%

The sensitivity analysis clearly shows that the project is only viable if the income from the sale of carbon credits is included. All the cases without CDM are quite far from the investment benchmark of 15%

Step 3: Barriers analysis

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

Apart from the financial barrier that has already been demonstration in step 2, there exist other barriers that would impede the project activity, including barriers due to prevailing practice and technological barriers.

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

- *Barriers due to prevailing practice:*
  As indicated above, the use of open digester tanks and lagoons are clearly in accordance to the palm oil industrial norms of POME treatment. The current system is able to treat the POME to meet the discharge requirements by the authority. As opposed to the project activity, the current system is relatively easy to maintain and there exist no reason to substitute the existing systems.

  The project activity would be one of the "first of its kind" in the palm oil industries in Malaysia. Although discussions on closed tank anaerobic digesters began in the mid 1980s, there has been no major uptake of this technology since then; further revealing the existence of various barriers. Currently, there is only one similar project (Keck Seng Palm Oil Mill) at full scale operation which was built as early as 1986 (Jaafar and Tong 2004).

- *Technological Barriers*
  The technological aspects of the project activity are more complicated than the baseline scenario. An existing pilot project similar to the project activity discovered that biogas plant performance is very sensitive and subject to different variables including loading rate, mixing, etc (Hassan *et al* 2005). There is a need for skilled and experienced operators and the availability of such personnel locally is limited as biogas systems are still sparse. Intensive operational monitoring and maintenance introduce higher operational cost.

  Currently, there are only a few closed tank anaerobic digester technological providers in Malaysia. Formal training, technological programmes and research institutes are lacking. Recently, an international research and development collaboration was established between University Putra Malaysia, FELDA (Federal Land Development Authority, government owned Palm Oil Company) and the Kyushu Institute of Technology Japan in the area of biogas plants. This further indicates that technological development of the technology is still in the development phase where many technological barriers exist. In fact, the pioneer anaerobic digester tank system in Malaysia was built at Tennamaram Palm Oil Mill, but is no longer operational due to technical problems, demonstrating the high technological barrier.

This technological barrier will not avoid the baseline scenario since open digester tanks and lagoons have been practiced since the start of the POME treatment technology in Malaysia.

Step 4: Common practice analysis

Sub-step 4a. Analyze other activities similar to the proposed project activity:
Conventionally, the POME is treated in open ponding system. At the project site, the existing POME treatment method will remain as it is as long as the treated effluent meets regulated standards prior to its discharge. Other systems, apart from ponds, such as open tank digesters and closed tank digesters with biogas recovery were introduced in 1980s'. However, the application of tank digesters, especially with biogas recovery, is not very common, as only two plants were established: The Tennamaram Mill in Selangor and Keck Seng Mill in Johor (Eco-Ideal 2004). The biogas system in Tennamaram Mill is no longer active due to problems with the utilisation of the biogas for power production. The Keck Seng Mill has been in operation since 1986 (Jaafar and Tong 2004)

One other biogas plant is under commissioning at the Kim Loong palm oil mill in Kota Tinggi. This project is registered as CDM in April 2007. Further a number of biogas plants are under validation as CDM projects. According to the UNFCCC website the following projects are under validation[6]: TSH Kunak Palm Oil Mill; United Plantations Jendaranta Palm Oil mill and SIME Plantations bundled Methane Extraction Projects at five palm oil mills, but none of the plants have been commissioned yet.

Sub-step 4b. Discuss any similar options that are occurring:
Out of approximately 400 palm oil mills in Malaysia there are three palm oil mills with biogas digesters and a further eight projects under development including the present project. Of these eleven projects two were developed in the 1980-ies with a view that saved fuel costs would make the biogas attractive. The experience with the technology was not convincing and there was no take up of the use of biogas to treat POME in the palm oil sector until the CDM came in to provide an extra source of income.

The introduction of CDM provides as demonstrated in step 2b and 2c of the additionality analysis provides an extra income stream for the biogas plant and makes in investment attractive. Therefore a number of biogas projects are taking off in these years, but only projects conducted as CDM projects.

Impact of CDM registration

As described in Step 2, the approval and registration of the project activity will alleviate the economic barrier of the project activity thus enabling the project to be undertaken by providing necessary an extra source of income for the project. The registration of the project will also allow opportunities for biogas technology providers to build on local experiences and the technological transfer benefits will not only benefit the project participants, but the whole industry.

The successful implementation of the project activity will encourage other palm oil mills to implement similar systems in the future and will significantly reduce the GHG emission (particularly methane) from POME, which is one of the major methane emission sources in Malaysia (MOSTE 2000). The successful implementation of the project will also contribute to improve the image of palm oil, as this should eliminate methane emission from palm oil mills.

[6] As of April 1st 2007

The project activity, which also acts as a renewable energy project, will also support the sustainable development of Malaysia, particularly in terms of sustainable energy development. The project is in line with the national policy encouraging renewable energy development.

The additionality analysis through the steps elaborated above justifies that the project activity is not part of the baseline and is hence additional.

B.6. Emission reductions:

B.6.1. Explanation of methodological choices:

Project Emissions:

The project boundary encompasses the anaerobic digester tanks (excluding the existing anaerobic lagoon that will be removed once the project activity is implemented) and the biogas capture, delivery and combustion system that include the boiler and emergency gas flare systems, as shown in Figure 5 below. The project activity will close the open anaerobic tanks to capture the methane. The POME will be distributed into the digesters at appropriately spaced inlets at the bottom and flows to the top in an upward direction for anaerobic removal of organic materials in the POME. While the partially treated POME is channelled into aerobic ponds for further treatment, the captured biogas is pumped through a pipeline delivery system to the boiler for generating steam. The steam will be fed into a steam turbine for electricity production for use at the palm oil mill, in a new kernel crushing plant and other downstream projects.

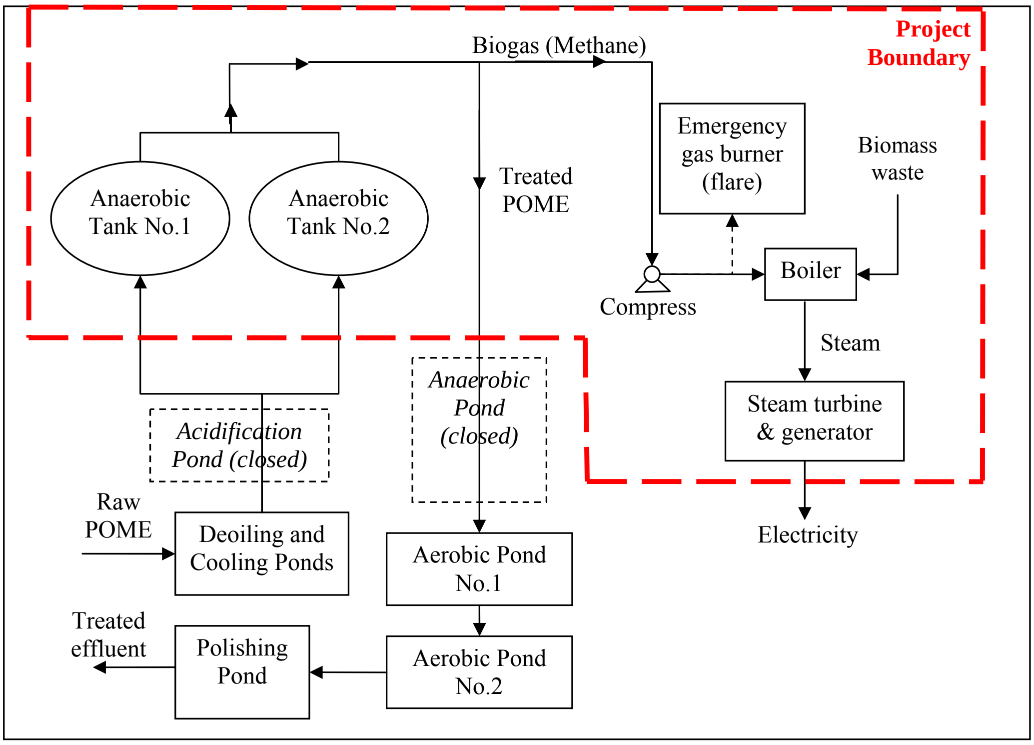

Figure 5: Project boundary

Total estimated project emissions are the sum of fugitive methane emissions from the subsequent anaerobic lagoon after the new closed tank digesters, from possible methane emissions from the new closed tank digesters, and from incomplete biogas combustion and biogas leaks. Total project emission (E_{PA}) is calculated using Equation 1 in AM0022 as follows:

$$E_{PA} = E_{CH4\_lagoons\_PA} + E_{CH4\_NAWTF} + E_{CH4\_IC+leaks} + E_{CO2\_diesel\_PE}$$

Where:

$E_{CH4\_lagoons\_PA}$ = fugitive methane emissions from the subsequent anaerobic lagoon after the closed digester tanks

E_{CH4_NAWTF} = fugitive methane emissions from the closed anaerobic digester tanks

$E_{CH4\_IC+leaks}$ = methane emissions from inefficient combustion and leaks in biogas pipeline delivery system

$E_{CO2\_diesel\_PE}$ = emissions from use of diesel as back up fuel

Fugitive methane emissions from the subsequent anaerobic lagoon after new closed tank digesters ($E_{CH4\_lagoons\_PA}$):

The project activity will close the existing open anaerobic tanks, thus converting them into closed anaerobic digesters for capturing of biogas generated. The POME will be treated in the closed tanks for anaerobic removal of its organic materials, which is expected to range from 90% to 95%. With such removal rate, the existing anaerobic lagoon will be removed after the implementation of the project activity. The treated POME will, therefore, be channelled into the subsequent aerobic and polishing lagoons for further treatment before the final discharge is used for land application. The aerobic lagoons will remove the remaining organic materials in the wastewater under aerobic condition and methane emission is expected to be insignificant. Therefore, there will be no further fugitive methane emissions from the lagoons after the anaerobic digester tanks.

Fugitive methane emissions from the closed anaerobic digester tanks (E_{CH4_NAWTF}):

With the implementation of the project activity, the existing open anaerobic digester tanks will be totally enclosed and will not emit any methane. Thus the fugitive methane emission from the closed anaerobic digester tanks (E_{CH4_NAWTF}) for this project is not further considered in this project.

Methane emissions from inefficient combustion and leaks in biogas pipeline delivery system:

Combustion of methane captured in the closed anaerobic tanks will only take place in the boiler and the flare. Flaring will only take place in emergency cases, when the boiler is not functioning. These processes are the sources for methane emissions during inefficient combustion. Methane emissions from the combustion in the boiler will be included into project emissions calculation using Equation 7 in AM0022 as follows:

$$E_{CH4\_IC} = (\sum V_r \times C_{CH4} \times (1 - f_r) \times GWP_{CH4}) + PE_{flare}$$

Where:

The sum is made over two routes *r* for methane destruction – combustion in biomass boiler and combustion in the enclosed flare;

V_r is the biogas combustion process volume in route *r* (Nm^3)

C_{CH4} is the methane concentration in biogas (tCH_4/Nm^3) to be measured on wet basis

f_r is the proportion of biogas destroyed by combustion

PE_{flare} are the project emissions from flaring of residual gas stream (tCO_2 e) calculated using the procedures described in the "Tool to determine project emissions from flaring gases containing methane". PE_{flare} can be calculated on an annual basis or for the required period of time using this tool.

Methane emission from boiler

The biogas will be combusted in the biomass boiler together with solid biomass waste. The expected emission of biogas from stationary combustion is very low according to IPCC[7] (2006). Here the default value of methane emissions from stationary combustion is given as 1 kg CH4/TJ. Since there is more than 100% uncertainty a conservativeness factor of 1.37 is used. This means that the emission will be 1.37 kg methane or 28.77 kg CO2-eq per TJ of biogas burned. The total amount of biogas is 114.6 TJ for the years with the expected maximum production. Multiplying 114.6 TJ with 28.77 kg/TJ gives a maximal emission of 3.3 t CO2-eq/year.

Methane emissions from enclosed flare

The project proposed will be of the **enclosed flare** type all though methane is not expected to be flared on routine operation day and will only be flared in the event of emergency (i.e. equipment malfunction).Project emissions from flaring will be calculated and monitored according to the procedures describe in the "*Tool to determine project emissions from flaring gases containing methane*".

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[7] IPCC 2006 Guidelines for National Greenhouse Gas Inventories, Volume 2 Energy Chapter 2 Stationary Combustion – table 2.3. Emission factors for Manufacturing Industries and Construction

This tool is applicable under the following conditions:

- The residual gas stream to be flared contains no other combustible gases than methane, carbon monoxide and hydrogen
- The residual gas stream to be flared shall be obtained from decomposition of organic material (through landfills, bio-digesters or anaerobic lagoons, among others) or from gases vented in coal mine (coal mine methane and coal bed methane)

Both conditions are fulfilled for this project.

The tool involves the following seven steps:

Step 1	Determination of the mass flow rate of the residual gas that is flared
Step 2	Determination of the mass fraction of carbon, hydrogen, oxygen and nitrogen in the residual gas
Step 3	Determination of the volumetric flow rate of the exhaust gas on a dry basis
Step 4	Determination of the methane mass flow rate of the exhaust gas on a dry basis
Step 5	Determination of the methane mass flow rate of the residual gas on a dry basis
Step 6	Determination of the hourly flare efficiency
Step 7	Calculation of annual project emissions from flaring based on measured hourly values or based on default flare efficiencies.

The residual gas from project activity shall be combusted as **enclosed flare and monitored continuously** for the flare efficiency. The flare efficiency in the hour, *h* (η_{flare}) is:

- 0% if the temperature of the exhaust gas of the flare (T_{flare}) is below 500 °C during more than 20 minutes during the hour, *h*
- Determined as follows in cases where the temperature of the exhaust gas of the flare (T_{flare}) is above 500 °C for more than 40 minutes during the hour, *h*

$$\eta_{flare,h} = \frac{1 - TM_{FG,h}}{TM_{RG,h}}$$

where,

Variable	SI Unit	Description
$TM_{FG,h}$	kg/h	Methane mass flow rate in the exhaust gas average in a period of time, *h*
$TM_{RG,h}$	kg/h	Methane mass flow rate in the residual gas stream in the hour, *h*
η_{flare}	-	Flare efficiency in the hour, *h*

Project emission from each hour *h,* based on the methane flow rate in the residual gas ($TM_{RG,h}$) and the flare efficiency during each hour *h* ($\eta_{flare,h}$) is as follows:

$$PE_{flare,y} = \sum^{8760} TM_{RG,h} \times (1 - \eta_{flare,h}) \times GWP_{CH4}$$

Variable	SI Unit	Description
$PE_{flare,y}$	tCO_2	Project emissions from flaring of the residual gas stream in year, *y*
$\eta_{flare,h}$	-	Flare efficiency in hour, *h* based on default values

GWP $_{CH4}$	tCO_2e/tCH_4	Global Warming Potential of methane valid for the commitment period (21)
$TM_{RG,h}$	kg/h	Mass flow rate of methane in the residual gas stream in the hour, *h*

For *ex-ante* calculation for determination of project emission from flaring of methane, $PE_{flare,y}$, the tool's steps **1 – 4** will not be included but for the actual project activity data collection, all the 7 steps has to be followed as the flaring shall be enclosed type and continuously monitored.

Mass flow rate of methane in the residual gas stream, $TM_{RG,h}$ shall be determined by using data from the calculation on the biogas extracted.

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

where,

Variable	SI Unit	Description
$FV_{RG,h}$	m^3/h	Volumetric flow rate of the RG in dry basis at normal conditions in the hour, *h*
$fv_{CH4,RG,h}$	-	Volumetric fraction of component CH_4 in the RG in the hour, *h*
$\rho_{RG,n,h}$	kg/m^3	Density of the RG at normal conditions in hour, *h*
$TM,_{RG,h}$	kg/h	Mass flow rate of methane in the residual gas stream in the hour, *h*

For project activity, residual gas volumetric flow rate, $FV_{RG,h}$ shall be measured by flow meter installed to delivery pipeline to the enclosed flare burner.

Methane concentration in residual gas ($fv_{CH4,RG,h}$) shall be measured by methane detector and logger. The measurement of methane flow and pressure will carried out continuously, even at the flare. This means that at the flare and under normal conditions, the device shall measure the background methane reading, during flaring, it measures the uncombusted methane concentration and if there is a leak, it measures the leakage methane concentration. In other words, the concentration at the flare is recorded at all times. Data will be stored for the at least 2 years after the end of the crediting period.

Since the flare is not expected to be operational under normal conditions no emissions are included in the calculation of project emissions.

Fugitive methane emissions from biogas system
As described in detail in section B3 every effort will be made to avoid leakages in the biogas system. This is done both to reduce emissions, but in an even higher extent for security concerns since leaking biogas would create a danger for fire. Therefore will there also be conducted annual leak detection test by using detergent solution spraying/applying on the pipe joints and any suspected pipe surface. Similar tests will be conducted on the on the welding joints or any suspected surface of the roof of the tank digestors.

Therefore no leakages from the system are included in the estimation of project emissions. The leakage is anticipated to be negligible compared to the baseline methane emissions due to the following:

- Short piping of biogas from closed tank to boilers (less than 2 km);
- Use of high quality delivery system (piping, fixture, pumps);
- Regular maintenance and monitoring of the system will be carried out.

Monitoring test (annually) will be carried out on the whole methane collection system and the leakage in the pipelines will be detected using electronic methane detector. If a leakage is observed there will be deducted 5[8]% of the annual methane production as project emissions.

Deleted: If any leakage from biogas system is found to be significant (> 1% of CER), it will be accounted into project emissions.

CO_2 emissions from fossil fuel use for back up for biomass boiler ($E_{CO2\_diesel\_PE}$):

The biogas will partly be used to replace the diesel emissions from the existing diesel generator. During normal operations some shell will be replaced by the biogas. The surplus of shell will be used for power production for staff quarters when mill is not running. This may lead to short term storage of up to one months of the shell. At night the diesel set is running for power for the staff quarters. In the future the shell and biogas will replace some diesel. Diesel data will be included in baseline – and some savings will be anticipated.

The use of diesel is considered in calculating CO_2 emissions in accordance to Equation 9 in AM0022:

$E_{CO2\_diesel\_BL}$ = F x NCV x EF

Where,

F	=	the amount of diesel is estimated by use of the annual processing of FFB
NCV	=	net calorific value of the diesel, i.e. equals to 0.04333 TJ/tonne
EF	=	emission factor of the diesel, i.e. equals to 74 tCO_2/TJ

Temporary storage of biomass

The biogas will replace the use of diesel and palm kernel shells. The extra biomass resource will be used to increase the supply of power to staff quarters at time where the palm oil mill is not producing i.e. a night and in some periods of the weekend. The palm kernel shell is expected to be stored on the site for 1-2 months before being feed to the boiler.

The emissions from the temporary storage can be estimated by the “Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site”. The tool is designed to assess methane emissions from multi annual depositions and not temporary storage anyway the tool is used to assess the possible emissions from temporary storage of palm kernel shells. In order to be conservative the emissions are assessed using 25% of the methane emissions from first years emission (equivalent to 3 months) even though the maximum expected storage is 1-2 months.

Palm kernel shells can be assessed either using the parameters for “wood waste” or for “garden waste”. Since the parameters for “garden waste” gives the highest emissions these are chosen. The MCF factor is 0.4 since the temporary storage will be shallow and not managed as a landfill – but as a storage. There will be no cover or other elements to promote anaerobic degradation of the shells.

At the maximum biogas will replace up to 6023 t palm kernel shells/year (based on 104.2 TJ biogas and 17.3 GJ/ton[9] energy value of palm kernel shells). The annual amount of CO2-eq from methane emissions from such deposit in the first year will be 475 t CO2-eq/year with use of parameters for “garden waste” and 224 t CO2-eq/year with use of parameters for “wood waste”. Recalculated to 3 months the numbers

[8] IPCC 2006: Volume 5, Chapter 4 p 4

[9] “Renewable Energy Resources” Danida/PTM/MEWC/EPU 2004. Available from the homepage www.eib.org.my

become 119 t CO2-eq/year and 56 t CO2-eq/year respectively. In order to be conservative 119 t CO2-eq has been added to the annual project emissions.

Baseline Emissions:

The baseline boundary encompasses both the anaerobic tanks and anaerobic lagoon, which are both open where organic materials are removed in anaerobic conditions, as shown in the Figure 6. The POME will go through digestion in the anaerobic tanks before being channelled into the anaerobic lagoon for further treatment.

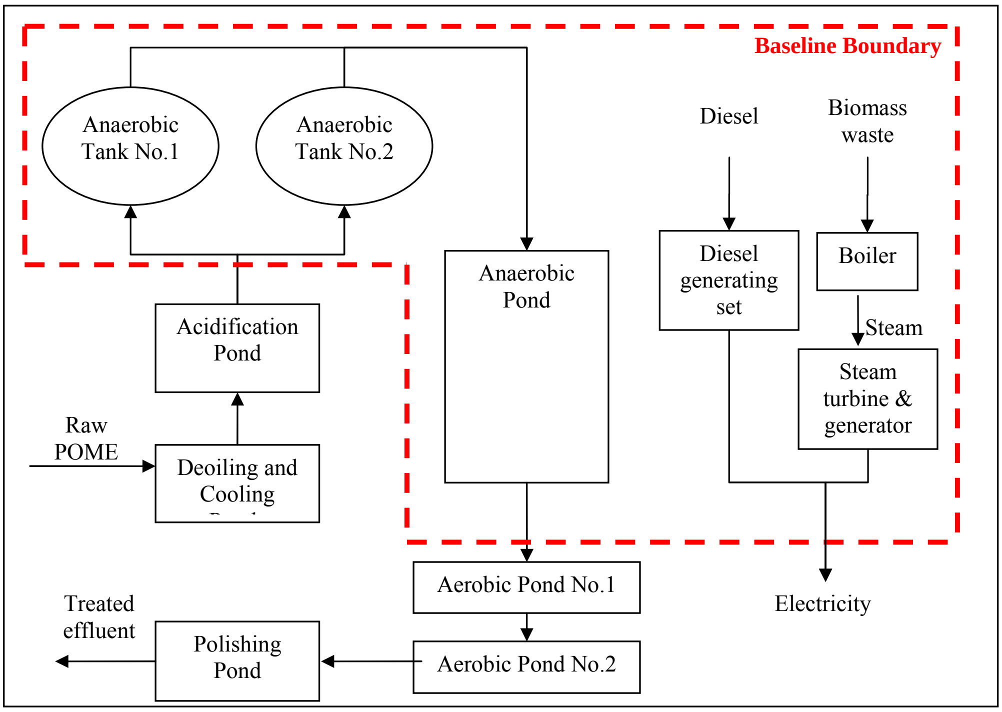

Figure 6: Baseline boundary

As the project activity will not consider the emissions displaced from the fuel switching in the heat and power generation, the total baseline emission (E_{BL}) comprise only the fugitive methane emissions from the existing anaerobic system that comprise digester tanks and anaerobic lagoon ($E_{CH4\_anaerobic\_BL}$), CO_2 emissions from fossil fuel use for diesel generator set for back up ($E_{CO2\_power\_BL}$) .Calculations are conducted using Equation 8 in AM0022:

$$E_{BL} = E_{CH4\_anaerobic\_BL} + E_{CO2\_power\_BL}$$

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Fugitive methane emissions from the existing anaerobic system ($E_{CH4\_anaerobic\_BL}$):

The fugitive methane emissions from the existing anaerobic system ($E_{CH4\_anerobic\_BL}$) are calculated using the formulae in Equation 2 in AM0022:

$E_{CH4\_anaerobic\_BL}$ = $(M_{BL\_tanks} + M_{BL\_lagoon})$ x EF_{CH4} x GWP_{CH4}

where:

M_{BL_tanks} = amount of organic material removed by the open anaerobic tanks

M_{BL_lagoon} = amount of organic material removed by the anaerobic lagoon

Amount of organic material removed by anaerobic processes in the tanks ($M_{BL\_\_tanks}$) and lagoon (M_{BL_lagoon}) is calculated with Equation 3 in AM0022:

$M_{BL\_\_tanks}$ = $M_{BL\_tanks\_total}$ - $M_{BL\_tanks\_aerobic}$ - $M_{BL\_tanks\_chemical\_ox}$ - $M_{BL\_tanks\_deposition}$

Where,

$M_{BL\_tanks\_total}$ = total amount of organic material removed in the existing open anaerobic tanks

$M_{BL\_tanks\_aerobic}$ = amount of organic material degraded aerobically in the existing open anaerobic tanks. It is surface aerobic losses of organic material in the tanks similar to pond based systems, i.e. equal to 254 kg COD per hectare of tanks surface area and per day lost through aerobic processes.

$M_{BL\_tanks\_chemical\_ox}$ = amount of organic material lost through chemical oxidation in the existing open anaerobic tanks. The entire palm oil milling process does not need any chemicals as a processing aid. There are traces of sulphate (SO_4) in the POME which leads to degradation into hydrogen sulphide (H_2S) found in traces in the biogas. This loss is estimated to 1%[10] of the organic matter.

$M_{tanks\_deposition}$ = amount of organic material lost through deposition in the existing open anaerobic tanks. The up-flow direction of the influent POME into the tanks prevents the settling of solids to the bottom; thus keeping the materials that would sediment in a state of permanent suspension. Furthermore, no desludging has been undertaken since the use of the tanks, indicating the insignificance of sedimentation that may have taken place. Therefore, the lost of organic material through deposition is considered negligible.

and,

M_{BL_lagoon} = $M_{BL\_lagoon\_total}$ - $M_{lagoon\_aerobic}$ - $M_{BL\_lagoon\_chemical\_ox}$ - $M_{lagoon\_deposition}$

Where,

$M_{BL\_lagoon\_total}$ = total amount of organic material removed in the anaerobic lagoon

$M_{lagoon\_aerobic}$ = amount of organic material degraded aerobically in the anaerobic lagoon. Surface aerobic losses of organic material in pond based systems equal to 254 kg COD per hectare of pond surface area and per day is assumed to be lost through aerobic processes.

$M_{BL\_lagoon\_chemical\_ox}$ = amount of organic material lost through chemical oxidation in the anaerobic lagoon. There are traces of sulphate (SO_4) in the POME which

[10] Chua N.S. and Gee P.T. Palm Oil Mill Engineers Course, Effluent treatment: Anaerobic digestion. Here the H_2S concentration in biogas is given as 500-1570 ppm – equivalent to roughly 1% reflecting the amount of the COD oxidised by SO_4

leads to degradation into hydrogen sulphide (H_2S) found in traces in the biogas. This loss is estimated to 1[1]% of the organic matter.

$M_{lagoon\_deposition}$ = amount of organic material lost through deposition in the anaerobic lagoon. No agitation for mixing is incurred in the lagoon. Sedimentation is expected to take place, but the sludge will stay long in the lagoon and slowly degrade at the bottom of the deep lagoon, leading to methane emission. In addition, desludging in the ponds is only undertaken with several years interval. Therefore, loss of COD due to deposition in the anaerobic is considered minimal and assumed as 10% of total organic material removed in the lagoon.

Total amount of organic material removed in the existing open anaerobic tanks ($M_{BL\_tanks\_total}$) and anaerobic lagoon ($M_{BL\_lagoon\_total}$) are calculated by using Equation 5 in AM0022:

$M_{BL\_tanks\_total} = M_{BL\_tanks\_input} \times R_{BL\_tanks}$

where,

$M_{BL\_tanks\_input}$ = input of organic material into the existing open anaerobic tanks

R_{BL_tanks} = total organic material removal ratio of the existing open anaerobic tanks. Calculation is undertaken based on the COD data of POME entering and leaving the existing open anaerobic tanks, which were measured before the project implementation. The following formula is applied for the calculation:

$$\frac{COD_{BL\_tank\_inlet} - COD_{BL\_tank\_outlet}}{COD_{BL\_tank\_inlet}}$$

The average value for $COD_{BL\_tank\_inlet}$ and $COD_{BL\_tank\_outlet}$ are 57.55 kg/m^3 and 10.493 kg/m^3, respectively. Therefore, R_{BL_tanks} equals to 0.82

and,

$M_{BL\_lagoon\_total} = M_{BL\_lagoon\_input} \times R_{BL\_lagoon}$

Where,

$M_{BL\_lagoon\_input}$ = input of organic material from the existing open anaerobic tanks into the anaerobic lagoon

R_{BL_lagoon} = total organic material removal ratio of the anaerobic lagoon. Calculation is undertaken based on the COD data of POME entering and leaving the existing anaerobic lagoon, which both measurements are shown in the above tables. The following formulae will be applied for the calculation:

$$\frac{COD_{BL\_lagoon\_inlet} - COD_{BL\_lagoon\_outlet}}{COD_{BL\_lagoon\_inlet}}$$

The average value for $COD_{BL\_lagoon\_inlet}$ and $COD_{BL\_lagoon\_outlet}$ are 10.493 kg/m^3 and 6.18 kg/m^3, respectively. Therefore, R_{BL_tanks} equals to 0.41

In accordance to Equation 11 and Equation 4 in AM0022, respectively:

$M_{BL\_tanks\_input} = M_{input\_total}$

$= Q_{POME\_inlet} \times COD_{BL\_tanks\_inlet}$

and,

$M_{BL\_lagoon\_input} = M_{input\_total} \times (1 - R_{BL\_tanks})$

where,

M_{input_total} = total organic material fed into anaerobic digester tanks (kg COD)

Q_{POME_inlet} = Volume of POME entering the anaerobic digester tanks (m^3)

$COD_{BL\_tanks\_inlet}$ = COD of POME entering the existing open anaerobic digester tanks (kg/ m^3)

CO_2 emissions from fossil fuel use for back up for biomass boiler ($E_{CO2\_power\_BL}$):

The current heat and power consumption on-site is produced using biomass waste (palm kernel shells, mesocarp fibres and empty fruit bunches) from the plant with a fossil diesel generator as backup. The use of diesel is required during start up, mal-functioning of biomass boilers or shortage of biomass fuel. The diesel is also partly used to supply staff quarters with power when the mill was closed.

Displaced electricity CO_2 emissions can be calculated as follows:
$E_{CO2\_powe\_BL} = EL*CEF$

Where:

EL is the amount of electricity displaced by the electricity generated from the biogas collected from the anaerobic treatment facility. This is estimated as product of :(1) Average specific electricity consumption for the output of the facility, estimated using 3 years historical data; and (2) the annual production .

CEF is the carbon emission factor for the electricity displaced by the electricity generated from the biogas. If in the baseline situation only one source of power is used (onsite production or grid), then apply the corresponding carbon emission factor.

EL has been calculated based on the power production related to the total processed Fresh Fruit Bunches (FFB) in the palm oil mill for the years 2005-2007. This specific power consumption is calculated as 2.6 kWh per t FFB processed (see Annex 3).

The annual processing of FFB is expected to be 250,000 tFFB/year in 2009 and 260,000 t FFB/year for the following years.

The only power supply to the mill is from the onsite diesel genset. The CEF for the genset is determined using table I.D.1 in AMS I.D (version 13) where 0.8 kg CO2/kWh is the lowest emission factor for diesel generators.

Leakage Emissions:

The project is not expected to have any off site effects on emissions and there will thus be no leakage effects.

Emission Reductions:

Emission reductions (ER) are calculated as the difference between baseline and project emissions in accordance to Equation 12 in AM0022. Leakage is considered to be negligible.

$$ER = E_{BL} - E_{PA} - E_{LE}$$

In order to ensure the above equation delivers a conservative estimate of emission reductions, it will be verified during the project implementation (see monitoring plan pg 32) that the emissions of CH_4 in the

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Deleted: The emissions from the use of diesel are calculated in accordance to Equation 9 in AM0022:¶
$E_{CO2\_diesel\_BL}$ = F x NCV x EF¶
where,¶
F = the amount of diesel used as back up calculated from the annual processing of FFB¶
NCV = net calorific value of the diesel, i.e. equals to 0.04333 TJ/tonne¶
EF = emission factor of the diesel, i.e. equals to 74 tCO_2/TJ¶
¶

calculated baseline are not higher than the total amount of biogas collected from the digester tanks and fugitive emissions from the tanks and lagoons using Equation 13 in AM0022 as follows:

$E_{CH4\_lagoon\_BL}$ - ($E_{CH4\_lagoons\_PA}$ + E_{CH4_NAWTF} + E_{CH4_coll})

Where :

E_{CH4_coll} = amount of methane expressed in (tCO2e) contained in the biogas collected from the anaerobic treatment facility (i.e. the sum of the biogas sent to the boiler and the biogas sent to the flare)

If this difference is positive, it will be deducted from the result obtained through the Equation 12 above in order to obtain the final estimation of the emissions reductions.

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

Data / Parameter:	$COD_{BL\_tanks\_inlet}$
Data unit:	kg/m^3
Description:	COD of POME entering the existing open anaerobic digester tanks
Source of data used:	Sampled
Value applied:	57.55
Justification of the choice of data or description of measurement methods and procedures actually applied :	Measurements were performed by Envilab Sdn. Bhd., an accredited laboratory to the National Laboratory Accreditation Scheme (SAMM), on a series of POME samples from 3-7 July 2006, using the Department of Environment (Malaysia) Revised Standard Methods (1985) for Analysis of Rubber and Palm Oil Mill Effluent. The analysis results are as follows:
Any comment:	-

Date	**COD (mg/L)**
3 July 2006	56,757
4 July 2006	58,105
5 July 2006	65,007
6 July 2006	54,254
7 July 2006	53,629
Average	**57,550**

Data / Parameter:	$COD_{BL\_tanks\_outlet}$ / $COD_{BL\_lagoon\_inlet}$
Data unit:	kg/m^3
Description:	COD of POME leaving the existing open anaerobic digester tanks / COD of POME entering the anaerobic pond
Source of data used:	Sampled
Value applied:	10.493
Justification of the choice of data or description of measurement methods and procedures actually applied :	Measurements were performed by Envilab Sdn. Bhd., a SAMM accredited laboratory, on a series of POME samples from 3-7 July 2006, using the Department of Environment (Malaysia) Revised Standard Methods (1985) for Analysis of Rubber and Palm Oil Mill Effluent. The analysis results are as follows:

Date	**COD (mg/L)**
3 July 2006	8,992

	4 July 2006 – 10,105 5 July 2006 – 10,967 6 July 2006 – 11,258 7 July 2006 – 11,141 **Average – 10,493**
Any comment:	The effluent from the anaerobic tanks is directly channelled into the subsequent anaerobic lagoon. No loss of organic material is expected in the short distance of transfer. Therefore, it is assumed that both COD values are similar.

Data / Parameter:	$COD_{BL\_lagoon\_outlet}$
Data unit:	kg/m^3
Description:	COD of POME leaving the anaerobic pond
Source of data used:	Sampled
Value applied:	6.18
Justification of the choice of data or description of measurement methods and procedures actually applied :	Measurements were performed by Envilab Sdn. Bhd., a SAMM accredited laboratory, on a series of POME samples from 3-7 July 2006, using the Department of Environment (Malaysia) Revised Standard Methods (1985) for Analysis of Rubber and Palm Oil Mill Effluent. The analysis results are as follows: **Date – COD (mg/L)** 3 July 2006 – 6,499 4 July 2006 – 6,466 5 July 2006 – 5,754 6 July 2006 – 6,161 7 July 2006 – 6,020 **Average – 6,180**
Any comment:	-

Data / Parameter:	**Diesel fuel used in the baseline**
Data unit:	Litre diesel/year
Description:	Diesel was mainly used for back up and start up fuel in the original cogeneration plant, but also to supply the staff quarters with power when the plant was closed.
Source of data used:	The diesel used has been included (as costs) in the audited accounts of the company. These data has been extracted for the baseline.
Value applied:	1.6 litre of diesel/t FFB processed.
Justification of the choice of data or description of measurement methods and procedures actually applied :	The audited accounts include the costs for diesel used in the plant historically. The accounts have been audited by an external auditor and are thus of a high validity as data source.
Any comment:	The monthly data for diesel consumption as presented in Annex X show a strong link between the use of diesel and the amount of processed amount of FFB. Since the amount of FFB processed varies between years it is suggested to use the relation between FFB processed and diesel consumption to calculate the baseline

	consumption of diesel.

Data / Parameter:	NCV_{diesel}
Data unit:	GJ/t
Description:	Net caloric value of diesel used in the base line
Source of data used:	IPCC 2006 default value
Value applied:	43.33
Justification of the choice of data or description of measurement methods and procedures actually applied :	The net-emissions from diesel are expected to be low. The uncertainty incurred by using default values will thus be minimal and not justify spending resources on measurements for a standard value as NCV of diesel
Any comment:	

Data / Parameter:	$EF_{CO2,FF,diesel}$
Data unit:	tCO_2/GJ
Description:	CO_2 emission factor for diesel
Source of data used:	IPCC 2006 default value
Value applied:	74.1
Justification of the choice of data or description of measurement methods and procedures actually applied :	The net-emissions from diesel are expected to be low. The uncertainty incurred by using default values will thus be minimal and not justify spending resources on measurements
Any comment:	With a density of 0.84 t/m^3 the EF per litre diesel can be calculated as Density*NVC*EF/1000 = 2.7 kg CO_2/litre

Data / Parameter:	EF_{CH4} **Methane emission from burning of biogas in boiler**
Data unit:	Kg/TJ
Description:	Remaining emission of methane from combustion of biogas in the existing biomass boiler
Source of data used:	IPCC 2006 default value
Value applied:	1.37 kg methane/TJ (calculated as the original 1 kg methane/TJ * conservativeness factor of 1.37)
Justification of the choice of data or description of measurement methods and procedures actually applied :	The methane emission is relatively uncertain, and thus is a high conservativeness factor used in calculating the annual emissions. Despite this are the emissions very low compared to the total amount of CERs generated in the project (less than 1%) and it is not deemed necessary to measure the amount.
Any comment:	The existing biomass boiler will continue to combust solid biofuels after the biogas comes in as part of the fuel. It will not be possible to measure the contribution of methane in the flue gas from the biogas and the biomass fuels respectively. Therefore it is suggested to use the IPCC value for combustion of biogas as default value.

Data / Parameter:	$\eta_{flare,h}$ **Flare efficiency**
Data unit:	%
Description:	Flare efficiency of methane destroyed by combustion in flaring
Source of data used:	Tool to determine project emissions from flaring gases containing

	methane
Value applied:	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*.
Justification of the choice of data or description of measurement methods and procedures actually applied :	1. 2. This value is prescribed by the "Tool"
Any comment:	In cases where the temperature is above 500 °C the flare efficiency will be monitored according to the monitoring plan.

B.6.3 Ex-ante calculation of emission reductions:

Project Emissions:

Fugitive methane emissions from the subsequent anaerobic lagoon after new closed tank digesters ($E_{CH4\_lagoon\_PA}$):
The existing anaerobic lagoon will be removed after the implementation of the project activity. The treated POME will be channelled into the subsequent aerobic ponds. There are not expected to be any change in the methane emissions from the aerobic ponds compared with the baseline. Therefore, there will not be included further fugitive methane emissions from the lagoons after the anaerobic digester tanks.

Fugitive methane emissions from the closed anaerobic digester tanks (E_{CH4_NAWTF}):
The tanks will be totally enclosed. No emission is expected from this source. (See further justification in Section B3). If leaks are identified during the annual leak tests 5% of the annual biogas production is deducted as project emissions in any case losses appear and these losses are less or equal to 5 %. In case the measured/monitored leakage would be higher than 5 % then the actual value of the leakage will be deducted.

Deleted: (See further justification in Section B3)

Methane emissions from inefficient combustion and leaks in the biogas pipeline delivery system ($E_{CH4\_IC+leaks}$):
Methane is assumed to be almost fully combusted in the project case. The residence time of the methane will be high in the biomass boiler compared with a gas engine. Therefore the combustion is expected to be very efficient. The IPCC default emission factor of 1 kg methane/TJ is used as a starting point to calculate the emission from the boiler. The methane emissions from the biomass boiler will be monitored during operations.

The enclosed flare is not expected to be used during normal operations. The volume of gas combusted in the flare and the flare efficiency will be monitored as prescribed by the Tool to determine project emissions from flaring gases containing methane.

No leakage is assumed to occur in the present calculation.

TABLE 6: TOTAL PROJECT EMISSIONS (E_{PA}):

Year	$E_{CH4\_lagoons\_PA}$ (tCO_2e)	E_{CH4_NAWTF} (tCO_2e)	$E_{CH4\_IC+leaks}$ (tCO_2e)	$E_{CO2\_diesel\_PE}$ (tCO_2e)	Emission from biomass	E_{PA} (tCO_2e)

				storage		
2008 (5 months)	0	0	**1.5**	**129**	**54**	**185**
2009	0	0	**2.9**	**337**	**104**	**443**
2010	0	0	**3.3**	**350**	**119**	**472**
2011	0	0	**3.3**	**350**	**119**	**472**
2012	0	0	**3.3**	**350**	**119**	**472**
2013	0	0	**3.3**	**350**	**119**	**472**
2014	0	0	**3.3**	**350**	**119**	**472**
2015	0	0	**3.3**	**350**	**119**	**472**
2016	0	0	**3.3**	**350**	**119**	**472**
2017	0	0	**3.3**	**350**	**119**	**472**
2018 (7 months)	0	0	**1.6**	**204**	**58**	**264**

Baseline Emissions:

Table 7: The fugitive methane emissions from the existing anaerobic system ($E_{CH4\_anaerobic\_BL}$):

Year	$M_{BL\_tanks\_anaerobic}$ (t COD)	$M_{BL\_lagoon\_anaerobic}$ (t COD)	EF_{CH4} (tCH_4/tCOD)	GWP_{CH4}	$E_{CH4\_anaerobic\_BL}$ (t CO_2e)
2008 (5 months)	3,106	95	0.21	21	**14,117**
2009	8,122	296	0.21	21	**37,124**
2010	8,448	309	0.21	21	**38,616**
2011	8,448	309	0.21	21	**38,616**
2012	8,448	309	0.21	21	**38,616**
2013	8,448	309	0.21	21	**38,616**
2014	8,448	309	0.21	21	**38,616**
2015	8,448	309	0.21	21	**38,616**
2016	8,448	309	0.21	21	**38,616**
2017	8,448	309	0.21	21	**38,616**
2018 (7 months)	4,929	183	0.21	21	**22,541**

TABLE 8: TOTAL BASELINE EMISSIONS (E_{BL}):

Year	ECH4_anaerobic_BL (t CO2e)	(ECO2_power_BL)	**E_{BL} (t CO_2e)**
2008 (5 months)	14,117	199	**14,316**
2009	37,124	520	**37,644**
2010	38,616	541	**39,157**

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2011	38,616	541	**39,157**
2012	38,616	541	**39,157**
2013	38,616	541	**39,157**
2014	38,616	541	**39,157**
2015	38,616	541	**39,157**
2016	38,616	541	**39,157**
2017	38,616	541	**39,157**
2018 (7 months)	22,541	315	**22,857**

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Leakage Emissions:

Leakage is considered to be negligible.

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

TABLE 9: EMISSIONS REDUCTION (ER):

Year	Total Baseline Emissions, E_{BL} (t CO_2e)	Total Project Emissions, E_{PA} (t CO_2e)	Total Leakage Emissions, E_{LE} (t CO_2e)	**Emissions Reduction, ER (t CO_2e)**
2008 (5 months)	14,316	185	0	**14,131**
2009	37,644	443	0	**37,200**
2010	39,157	472	0	**38,685**
2011	39,157	472	0	**38,685**
2012	39,157	472	0	**38,685**
2013	39,157	472	0	**38,685**
2014	39,157	472	0	**38,685**
2015	39,157	472	0	**38,685**
2016	39,157	472	0	**38,685**
2017	39,157	472	0	**38,685**
2018 (7 months)	22,857	264	0	**22,593**
TOTAL	**388,070**	4,669	**0**	**383,401**
Average	**38,807**	**467**	**0**	**38,340**

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

B.7.1 Data and parameters monitored:

ID No.:	1.

Data / Parameter:	$Q_{POME\ inlet}$
Data unit:	m^3
Description:	Volume of POME entering the anaerobic digester tanks
Source of data to be used:	Measured
Value of data applied for the purpose of calculating expected emission reductions in section B.5	The actual POME volume generated will be monitored during the project implementation. For present estimation purposes, the amount of POME generated is estimated based on the FFB processed in the Mill, i.e. 0.7 m^3 POME/t FFB (refer Annex 3 for details). The present annual FFB production level is 210,000 tonnes and is expected to increase from year 2008 onwards. Annual volume of POME to be treated are shown in the following table: (see table below) The maximum generation of POME will occur if the plant is used to its full capacity of 330,000 t FFB per year. That will lead to total annual POME volume of 231,000 m^3 by using the same assumption as above. The actual volume of POME will be based on the measurement at the plant each year.
Description of measurement methods and procedures to be applied:	Flowmeter will be installed at the inlet to the digester tanks for measurement of the influent wastewater into the tanks. Continuous measurements are carried out using the flow meter and the measurements will be recorded monthly by the plant technician. When the meter is removed for off-site calibration, which will take place for several days, the POME will be channelled through bypass piping. The volume of POME during these few days will be calculated based on the average daily flow of the previous 3 month record.
QA/QC procedures to be applied:	The flowmeter is subject to annual calibration that will be done by the manufacturer in accordance to appropriate industry standards to ensure accuracy. Therefore the uncertainty level of the data is expected to be low. Records of calibration will be kept at site.
Any comment:	-

Year	**Annual FFB throughput (t)**	**Annual POME volume (m^3)**
2007	210,000	147,000
2008	230,000	161,000
2009	250,000	175,000
2010	260,000	182,000
2011	260,000	182,000
2012-2018	260,000	182,000

ID No.:	2.
Data / Parameter:	$Q_{POME\ outlet}$
Data unit:	m^3
Description:	Volume of POME leaving the anaerobic digester tanks
Source of data to be used:	Measured
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Assumed similar to the volume entering the anaerobic digester tanks as shown above. The actual volume of POME will be based on the measurement at the plant each year.

Description of measurement methods and procedures to be applied:	Flowmeter will be installed at the outlet to the digester tanks for measurement of the influent wastewater into the tanks. Continuous measurements are carried out using the flowmeter and the measurements will be recorded monthly by the plant technician. When the meter is removed for off-site calibration, which will take place for several days, the POME will be channelled through bypass piping. The volume of POME during these few days will be calculated based on the average daily flow of the previous 3 month record.
QA/QC procedures to be applied:	The flowmeter is subject to annual calibration that will be done by the manufacturer in accordance to appropriate industry standards to ensure accuracy. Therefore the uncertainty level of the data is expected to be low. Records of calibration will be kept at site.
Any comment:	-

ID No.:	3.
Data / Parameter:	$COD_{PA\_tanks\_inlet}$
Data unit:	Kg COD/m^3
Description:	COD of POME entering the closed anaerobic digester tanks
Source of data to be used:	Sampled
Value of data applied for the purpose of calculating expected emission reductions in section B.5	57.55 (assumed similar to the average level of the analysis results as shown in Annex 3)
Description of measurement methods and procedures to be applied:	Daily samples will be made and analysed at the palm oil mills laboratory according to the specification of the test equipment. Further will at least three POME samples per month be collected and analysed by a SAMM accredited laboratory using the Department of Environment (Malaysia) Revised Standard Methods (1985) for Analysis of Rubber and Palm Oil Mill Effluent.
QA/QC procedures to be applied:	The analysis at the plant will follow the standard and the equipment will be calibrated according to the instructions from the supplier. The appointed laboratory will be a SAMM accredited facility. The uncertainty level of the data will be low. The results from the mills own samples will be compared to the samples from the accredited laboratory and corrective actions undertaken if there are consistent differences.
Any comment:	If it is deemed relevant changes in the sampling frequency can be sought through an application for deviation

ID No.:	4.
Data / Parameter:	$COD_{PA\_tanks\_outlet}$
Data unit:	Kg COD/m^3
Description:	COD of POME leaving the closed anaerobic digester
Source of data to be used:	Sampled
Value of data applied for the purpose of calculating expected emission reductions in section B.5	10.493 (assumed similar to the average level of the analysis results as shown in Annex 3)
Description of measurement methods and procedures to be	Daily samples will be made and analysed at the palm oil mills laboratory according to the specifications of the test equipment.

applied:	Further will at least three POME samples per month be collected and analysed by a SAMM accredited laboratory using the Department of Environment (Malaysia) Revised Standard Methods (1985) for Analysis of Rubber and Palm Oil Mill Effluent
QA/QC procedures to be applied:	The analysis at the plant will follow the standard and the equipment will be calibrated according to the instructions from the supplier. The appointed laboratory will be a SAMM accredited facility. The uncertainty level of the data will be low. The results from the mills own samples will be compared to the samples from the accredited laboratory and corrective actions undertaken if there are consistent differences.
Any comment:	If it is deemed relevant changes in the sampling frequency can be sought through an application for deviation

ID No.:	5.
Data / Parameter:	V_{total}
Data unit:	Nm^3
Description:	Volume of biogas captured from the new closed digester tanks
Source of data to be used:	Measured
Value of data applied for the purpose of calculating expected emission reductions in section B.5	4.5 million m3/year at maximum expected production in 2010 The volume of biogas is calculated from the amount of methane produced according to AM00022 and with the use of the density of methane 0.656 kg/Nm3 (at 25^{o}C)[11] and the share of methane in the biogas (62.5% - ID no 11)
Description of measurement methods and procedures to be applied:	The flow meter will installed at the outlet of the overflow tank, where it is connected to the biogas delivery piping system. Continuous measurements are carried out using the flow meter and the measurements will be recorded monthly by the plant technician. When the meter is removed for off-site calibration, which will take place for several days, the biogas will be channelled through bypass piping. The volume of biogas during these few days will be calculated based on the average daily flow of the previous 3 month records.
QA/QC procedures to be applied:	The flow meter is subject to annual calibration that will be done by the manufacturer in accordance to appropriate industry standards to ensure accuracy. Therefore the uncertainty level of the data is expected to be low. Records of calibration will be kept at site.
Any comment:	An overflow tank will be constructed in order to prevent gas leakage from the enclosed anaerobic digester tanks. The overflow tank is the device where biogas and anaerobic liquor from the digester tanks are separated and the liquor can be discharged without escaping of the biogas. It is expected that all biogas generated in the digester tanks is channelled into the overflow tank for subsequent separation (from liquor) and flow into the biogas delivery piping.

[11] http://hypertextbook.com/physics/matter/density/

ID No.:	8.
Data / Parameter:	**Use of diesel in the Desa Kim Loong Palm Oil Mill**
Data unit:	Litre diesel/year
Description:	Diesel is used as backup and start up fuel
Source of data to be used:	Measuring of the volume of diesel used in the biomass power plant through establishing of a flow meter at the diesel back up
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0.5 litre diesel/t FFB. This is a reduction of almost 70% compared to the baseline emission.
Description of measurement methods and procedures to be applied:	Measurements will be continuous based on measurement of the flow of diesel from the storage tank to the diesel back up.
QA/QC procedures to be applied:	Cross check with the annual energy balance of the biomass power plant and with the invoices for purchased diesel
Any comment:	The diesel use is expected to be lower than the baseline as the biogas will give an extra energy source at the site to replace the diesel used.

ID No.:	9.
Data / Parameter:	$V_{flaring}$ (in AM00022)
Data unit:	Nm^3/year
Description:	Volume of biogas sent to flare
Source of data to be used:	Measured
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Expected to be zero. To be monitored during actual project implementation.
Description of measurement methods and procedures to be applied:	The flow meter is installed in the individual delivery pipeline to the waste gas burner (flare) after the branch from the main biogas. Measurements will only be carried out using the flow meter when flaring takes place and the results will be recorded by the plant technician. When the meter is removed for off-site calibration, which will take place for several days, the biogas will be channelled through bypass piping. The volume of biogas flared during these few days, if occurs, will be calculated as the difference of volumes between V_{total} and V_{heat}.
QA/QC procedures to be applied:	The flow meter is subject to annual calibration that will be done by the manufacturer in accordance to appropriate industry standards to ensure accuracy. Therefore the uncertainty level of the data is expected to be low. Records of calibration will be kept at site.
Any comment:	Flaring is not expected to be used during routine operations.

ID No.:	9A.
Data / Parameter:	$FV_{RG,h}$ (in Tool for flaring)
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:	Measured
Value of data applied for the	Expected to be zero. To be monitored during actual project

purpose of calculating expected emission reductions in section B.5	implementation.
Description of measurement methods and procedures to be applied:	The flow meter is installed in the individual delivery pipeline to the waste gas burner (flare) after the branch from the main biogas. It will be ensured that the same basis (dry) is considered for this measurement and the measurement of volumetric fraction of all components in the residual gas (fvi,h) when the residual gas temperature exceeds 60 ºC. Measurements will only be carried out using the flow meter when flaring takes place and the results will be recorded by the plant technician. When the meter is removed for off-site calibration, which will take place for several days, the biogas will be channelled through bypass piping. The volume of biogas flared during these few days, if occurs, will be calculated as the difference of volumes between V_{total} and V_{heat}.
QA/QC procedures to be applied:	The flow meter is subject to annual calibration that will be done by the manufacturer in accordance to appropriate industry standards to ensure accuracy. Therefore the uncertainty level of the data is expected to be low. Records of calibration will be kept at site.
Any comment:	Flaring is not expected to be used during routine operations.

ID No.:	10.
Data / Parameter:	V_{steam}
Data unit:	Nm^3
Description:	Volume of biogas send to biomass boiler
Source of data to be used:	Measured
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Assumed to be the total volume of biogas produced in biogas reactor. To be monitored during actual project implementation.
Description of measurement methods and procedures to be applied:	The flowmeter is installed in the individual delivery pipeline to the gen-set after the branch from the main biogas. Continuous measurements are carried out using the flowmeter and the measurements will be recorded monthly by the plant technician. When the meter is removed for off-site calibration, which will take place for several days, the biogas will be channelled through bypass piping. The volume of biogas during these few days will be calculated based on the average daily flow of the previous 3 month records.
QA/QC procedures to be applied:	The flow meter is subject to annual calibration that will be done by the manufacturer in accordance to appropriate industry standards to ensure accuracy. Therefore the uncertainty level of the data is expected to be low. Records of calibration will be kept at site.
Any comment:	-

ID No.:	11.
Data / Parameter:	C_{CH4} (in AM00022) and $fv_{CH4,h}$ (in Tool for flaring)
Data unit:	%

Description:	Methane concentration in biogas
Source of data to be used:	Measured
Value of data applied for the purpose of calculating expected emission reductions in section B.5	62.5% - based on the expected performance of the biogas digester
Description of measurement methods and procedures to be applied:	A methane detector and logger will be installed along with the flow meter for measuring the biogas captured from the digester tanks. The detector will continuously detect the concentration of methane in the captured biogas. The plant technician will record the results monthly. When the detector is removed for off-site calibration, which will take place for several days, the biogas will be channelled through bypass piping. The methane concentration of biogas during these few days will be calculated based on the average daily value of the previous 3 month records.
QA/QC procedures to be applied:	The methane detector is subject to annual calibration that will be done by the manufacturer in accordance to appropriate industry standards to ensure accuracy. Therefore the uncertainty level of the data is expected to be low. Records of calibration will be kept at site.
Any comment:	-

ID No.:	12.
Data / Parameter:	$PE_{flare,y}$
Data unit:	t CO2 – eq/year
Description:	Project emissions of methane from incomplete combustion in the enclosed flare
Source of data to be used:	Measurement and calculation by project participants
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Zero. Since no flow of methane to the flare is expected under normal operations. However the Project emissions from flaring of the residual gas steam shall be calculated by multiplying residual gas volumetric flow rate, $V_{flaring}$, volumetric fraction of methane C_{CH4} and density of methane (0.716) in dry basis at normal conditions in hour, *h,* with the flare efficiency to achieve the hourly project emissions. See full explanation in sector B. 6.1.
Description of measurement methods and procedures to be applied:	Based on reading recorded at flow meter installed in the individual delivery pipeline to the waste gas burner (flare) after the branch from the main biogas. Measurements will only be carried out using the flow meter when flaring takes place. Also based on monthly reading recorded by the technician from methane detector and logger installed along with the flow meter for measuring the biogas captured from the digester tanks. The detector will continuously detect the concentration of methane in the captured biogas.
QA/QC procedures to be applied:	
Any comment:	Flaring is not expected to be used during routine operations

ID No.:	12.a
Data unit:	mg/m^3
Description:	Concentration of methane in the exhaust gas of the flare in dry basis at normal conditions in the hour, *h*

Source of data to be used:	Measurements by project participants using a continuous gas analyser
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Not used for ex ante calculations
Description of measurement methods and procedures to be applied:	Continuously. Values to be averaged hourly or at shorter time interval.
QA/QC procedures to be applied:	The analyzer shall be operated and maintained as per the specifications prescribed by the manufacturer.
Any comment:	

ID No.:	12.b
Data unit:	-
Description:	Volumetric fraction of O_2 in the exhaust gas of the flare in the hour, *h*
Source of data to be used:	Measurement by project participants using a continuous gas analyser
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Not used for ex ante calculation
Description of measurement methods and procedures to be applied:	Continuous Extractive sampling analysers. Values to be averaged hourly or at shorter time interval.
QA/QC procedures to be applied:	The analyzer shall be operated and maintained as per the specifications prescribed by the manufacturer.
Any comment:	

ID No.:	12.c
Data unit:	m^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:	Measurement by project participants using a flow meter
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Not used for ex ante calculations
Description of measurement methods and procedures to be applied:	Flow rate shall be measured on wet basis. However, the volumetric fraction of moisture in the gas will be measured as well. Therefore, considering the volumetric fraction of moisture, measured data (volumetric flow rate of the residual gas) can be converted to the value on dry basis.
QA/QC procedures to be applied:	The analyzer shall be operated and maintained as per the specifications prescribed by the manufacturer.
Any comment:	

ID No.:	12.d
Data unit:	kg/h
Description:	Mass flow rate of methane in the residual gas in the hour,*h*
Source of data to be used:	Calculation

Value of data applied for the purpose of calculating expected emission reductions in section B.5	Not used for ex ante calculation
Description of measurement methods and procedures to be applied:	N/A
QA/QC procedures to be applied:	N/A
Any comment:	According to “tool to determine project emissions from flaring gases containing methane”.

ID No.:	12.e
Data unit:	^oC
Description:	Temperature in the exhaust gas of the flare
Source of data to be used:	Measurement by project participants
Value of data applied for the purpose of calculating expected emission reductions in section B.5	> 500 ^oC
Description of measurement methods and procedures to be applied:	Measure the temperature of the exhaust gas stream in the flare by a Type N thermocouple. The temperature above 500 ^oC indicated significant amount of gases are still being burnt and that the flare is operating.
QA/QC procedures to be applied:	Thermocouples should be replaced or calibrated yearly.
Any comment:	

ID No.:	12.f
Data unit:	bar
Description:	Pressure of the biogas
Source of data to be used:	Measured
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Not used in ex ante calculations
Description of measurement methods and procedures to be applied:	Measured by continuous by a pressure probe
QA/QC procedures to be applied:	Measured to determine density of methane, D_{CH4}. No separate monitoring is necessary if using flow meters that automatically measures pressure and temperature, expression LFG volumes in Nm^3.
Any comment:	Data shall be archived for at least 2 years

ID No.:	13.
Data / Parameter:	$C_{chemical\ ox}$
Data unit:	Kg SO_4 /m^3
Description:	Amount of the chemical oxidising agent – here only SO_4 - in the POME entering the anaerobic digester tanks
Source of data to be used:	Sampled
Value of data applied for the	Assumed 1% of total organic materials removed in the digester tanks

purpose of calculating expected emission reductions in section B.5	
Description of measurement methods and procedures to be applied:	Samples of POME will be collected and analysed by a SAMM accredited laboratory using the Department of Environment (Malaysia) Revised Standard Methods (1985) for Analysis of Rubber and Palm Oil Mill Effluent. The analysis results will be forwarded to the plant engineer for verification and record keeping. The sampling will be carried out daily for the first 3 months to observe the fluctuation pattern of chemical oxidising agents in the POME samples. If the 3-month results show no major fluctuation pattern, subsequent monitoring will be done once every month.
QA/QC procedures to be applied:	The appointed laboratory will be a SAMM accredited facility. The uncertainty level of the data will be low.
Any comment:	Chua N.S. and Gee P.T. Palm Oil Mill Engineers Course, Effluent treatment: Anaerobic digestion. Here the H_2S concentration in biogas is given as 500-1570 ppm – equivalent to roughly 1% reflecting the amount of the COD oxidised by SO_4

ID No.:	16.
Data / Parameter:	$Q_{POME\ bypass}$
Data unit:	m^3
Description:	Volume of POME entering the current water treatment system, bypassing the new wastewater treatment facility
Source of data to be used:	Measured
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:	If needed a flow meter will be installed at the pipeline bypassing the new wastewater treatment system facility. It is unlikely that any effluent bypassed to the existing lagoon after the project implementation.
QA/QC procedures to be applied:	The flow meter is subject to annual calibration that will be done by the manufacturer in accordance to appropriate industry standards to ensure accuracy. Therefore the uncertainty level of the data is expected to be low. Records of calibration will be kept at site.
Any comment:	No such bypass is foreseen, but if a bypass is established a flow meter will be installed

ID No.:	17.
Data / Parameter:	$E_{CH4\ leaks}$
Data unit:	tCO_2e
Description:	The welding and pipes in the biogas supply system are checked for leaks once per year
Source of data to be used:	Measured
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Zero – as no leaks are expected
Description of measurement	The tanks shall be subjected to hydrostatic test and gas-leakage test at

Deleted: Methane emissions from leaks in the biogas pipeline delivery system

Deleted: Measured

Deleted: Zero.

methods and procedures to be applied:	an expected maximum internal gas pressure of up to 300 mm water column (approximately 3.0 kPa) The main pipeline shall be pressure tested at 10 kg/cm^2 and checked for leaks along the pipeline.
QA/QC procedures to be applied:	The leakage checks will be verified against the mass balance of the biogas plant to substantiate if there have been any significant leaks
Any comment:	If leaks are identified during the annual leak tests 5% of the annual biogas production is deducted as project emissions in any case losses appear and these losses are less or equal to 5 %. In case the measured/monitored leakage would be higher than 5 % then the actual value of the leakage will be deducted.

Deleted: Annual monitoring test will be carried out by the plant engineer and technicians on the whole methane collection system to examine the integrity of biogas pipeline for losses of methane by pressurizing the system and establishing pressure drops through leakage.

Deleted: Annual checks to be carried out to international standards. Uncertainty level of the data is expected to be low.

Deleted: The leakage is anticipated to be negligible due to the short piping of biogas from closed tank to boilers (less than 2 km) and the use of high quality delivery system (piping, fixture, pumps). If any leakage from biogas system is found to be significant (> 1% of CER), it will be accounted into project emissions

ID No.:	18.
Data / Parameter:	Organic material removed from wastewater facility
Data unit:	ton COD/year
Description:	If sludge is removed from the biogas digester it will have to be estimated how big amount of COD is removed
Source of data to be used:	Calculated based on samples by project participants
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Zero as no sludge is expected to be removed from the biogas digester.
Description of measurement methods and procedures to be applied:	If sludge is removed from the biogas digester the trucks transporting it will have to be measured at the weighing bridge of the palm oil mill before and after the filling. From each truck three samples of the sludge will be taken to analyse the COD/ton. It can be necessary to dilute the sample to get proper measurements. The value of removed COD is calculated based on the total tonnage of the removed sludge and the COD content/ton.
QA/QC procedures to be applied:	The results of the calculation of the will be compared with earlier samples of the sludge and with the mass balance for COD for the biogas plant to verify the numbers.
Any comment:	

ID No.:	19.
Data / Parameter:	Net Calorific Value (NCV) of biogas
Data unit:	GJ/kg
Description:	Biogas calorific value
Source of data to be used:	Measured
Value of data applied for the purpose of calculating expected emission reductions in section B.5	The IPCC 2006 default value is 50.4 GJ/kg
Description of measurement methods and procedures to be applied:	Measurements shall be carried out at reputed laboratories and according to relevant international standards. Measurements done at least every twelve months, taking at least three samples for each measurement.
QA/QC procedures to be applied:	Check the consistency of the measurements by comparing the measurement results with measurements from previous years, relevant data sources (e.g. values in the literature, values used in the

	national GHG inventory) and default values by the IPCC. If the measurement results differ significantly from previous measurements or other relevant data sources, conduct additional measurements.
Any comment:	

The following items from the approved monitoring methodology are not relevant for the current project:

- ID. No.7, Electricity generated from the biogas collected in the anaerobic treatment facility and consumed on site or sent the grid
  The biogas is sent to the existing biomass boiler at the palm oil mill and it is thus not possible to specifically measure the power produced from the biogas

- ID No 14 Gen set combustion efficiency
  No generator set is used at for burning of the biogas

- ID No 15 Heating system combustion efficiency
  The biogas is burned together with the solid biomass so it's not possible to measure the combustion efficiency of the biogas in the heating system. In stead is IPCCs default value for methane emissions for industrial boilers used to estimate the project emissions

ID. No.12 a – 12f have been added to the list from the approved monitoring methodology and shall be monitored as it is an important parameter to determine project emissions from flaring gases containing methane.

Quality Control (QC) and Quality Assurance (QA) Procedures

ID number	Data monitored	Uncertainty level of data (High/Medium/Low)	Are QA/QC procedures planned for those data?	Outline explanation why QA/QC procedures are or not being planned
1.	Volume of POME entering the anaerobic digester tanks	Low	Yes	The flow meter is subject to annual calibration that will be done by the manufacturer and in accordance to appropriate industry standards to ensure accuracy. Records of calibration will be kept at site.
2.	Volume of POME leaving the anaerobic digester tanks	Low	Yes	The flow meter is subject to annual calibration that will be done by the manufacturer and in accordance to appropriate industry standards to ensure accuracy. Records of calibration will be kept at site.
3.	COD of POME entering the closed anaerobic digester tanks	Low/Medium	Yes	Daily samples will made at the mills own laboratory. The calibration procedure of the equipment will be used. Further will at least three samples per month be analysed at an appointed SAMM accredited laboratory. If there are systematic differences between the own laboratory and the external laboratory corrective actions will be taken.
4.	COD of POME leaving the closed anaerobic digester tanks	Low/Medium	Yes	Daily samples will made at the mills own laboratory. The calibration procedure of the equipment will be used. Further will at least three samples per month be analysed at an appointed SAMM accredited laboratory. If there are systematic differences between the own laboratory and the external laboratory corrective actions will be taken.
5.	Volume of biogas captured from the new closed digester tanks	Low	Yes	The biogas flow meter is subject to annual calibration that will be done by the manufacturer and in accordance to appropriate industry standards to ensure accuracy. Records of calibration will be kept at site.
8.	Fossil fuel volume equivalent to generate the same amount of heat generated from the biogas collected in the anaerobic treatment facility	Low	Yes	Cross check with the annual energy balance of the biomass power plant and with the invoices for purchased diesel.

ID number	Data monitored	Uncertainty level of data (High/Medium/Low)	Are QA/QC procedures planned for those data?	Outline explanation why QA/QC procedures are or not being planned
9.	Volume of biogas sent to flare	Low	Yes	Gas analysers shall be periodically serviced and calibrated to ensure accuracy.
ID number	**Data monitored**	**Uncertainty level of data (High/Medium/Low)**	**Are QA/QC procedures planned for those data?**	**Outline explanation why QA/QC procedures are or not being planned**
9A	Volumetric flow rate of the residual gas in dry basis at normal conditions in the hour *h*	Low	Yes	Gas analysers shall be periodically serviced and calibrated to ensure accuracy.
10.	Biogas combustion process volume to boiler	Low	Yes	Gas analysers shall be periodically serviced and calibrated to ensure accuracy.
11.	Methane concentration in biogas	Low	Yes	The methane detector is subject to annual calibration that will be done by the manufacturer in accordance to appropriate industry standards to ensure accuracy. Records of calibration will be kept at site.
12.	Mass flow rate of methane in the exhaust gas in the hour *h*	Low	Yes	Calculated based on 10 and 11 + the default flare efficiency. The results will be compared with previous values for consistency
12(a)	Concentration of methane in the exhaust gas of the flare in dry basis at normal conditions in the hour, *h*	Low	Yes	The methane analyzer is subject to annual calibration that will be done by the manufacturer in accordance to appropriate industry standards to ensure accuracy. Records of calibration will be kept at site.
12(b)	Volumetric fraction of O_2 in the exhaust gas of the flare in the hour, *h*	Low	Yes	The gas analyzer is subject to annual calibration that will be done by the manufacturer in accordance to appropriate industry standards to ensure accuracy. Records of calibration will be kept at site.
12(c)	Volumetric flow rate of the residual gas in dry basis at normal conditions in the hour,*h*, $FV_{RG,h}$	Low	Yes	The gas analyzer is subject to annual calibration that will be done by the manufacturer in accordance to appropriate industry standards to ensure accuracy. Records of calibration will be kept at site.
12(d)	Mass flow rate of methane in the residual gas in the hour,*h*	Low	No	Calculated based on *"tool to determine project emission from flaring gases containing methane"*. The results will be compared with previous values for consistency
12(e)	Temperature in the exhaust gas of the flare	Low	Yes	Thermocouple shall be calibrated annually and records kept on site.

12(f)	Pressure of the biogas	Low	Yes	Pressure probe is used to determine density of Methane. The probe shall be calibrated annually.
13.	Oxidizing chemical agents entering system boundary	Low	Yes	Samples will be sent to appointed SAMM accredited laboratory periodically.
16.	Volume of POME entering the current water treatment system, bypassing the new wastewater treatment facility	Low	Yes	The flow meter is subject to annual calibration that will be done by the manufacturer and in accordance to appropriate industry standards to ensure accuracy. Records of calibration will be kept at site.
17.	Loss of biogas from pipe line	Medium	Yes	Annual checks to be carried out to international standards and results cross checked with mass balance of the biogas production
18.	COD leaving the bio digester as sludge	Low	Yes	Will be calculated based on weight of lorries and COD of sludge. Weighing bridge will be calibrated regularly as part of mills commercial operation. COD measurements will be sent to appointed SAMM accredited laboratory.
19.	Net Calorific Value of biogas	Low	Yes	Comparison with IPCC standard values and results from previous years

B.7.2 Description of the monitoring plan:

The monitoring of emission reductions generated by the project activity will be carried out systematically according to the monitoring plan derived. Specific personnel will be assigned to be responsible for project management as well as for all the different parameters to be monitored and reported. Specifically, the following roles and responsibilities will be assigned:

- Managing Director – Financial and policy matters
- Project Coordinator – Design, training, system establishment and managing the CDM project
- Engineer – Construction, operation and maintenance of the CDM project
- Technicians – Daily operations including sampling, recording of readings and filing of records.

In order to lower the uncertainties and to produce accurate data, the following measures will be introduced:

- Appointment of accredited laboratories, purchase good quality measurement devices;
- Appropriate training for staff handling the monitoring;
- Clear procedures and guidelines for conducting the monitoring, including sampling and measurement methods, clear scheduling, recording, reporting and others;
- Provision of internal review, quality check and assurance procedures with a quality assurance manager appointed. Regular calibration and assessment of potential leakage to be monitored;
- Clear preventive and corrective actions to be prepared.

All data will be stored electronically and in paper at the plant till 2 years after the end of the crediting period under the purview of mill manager.

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

Date of completion of baseline study:
27/09/2007

Name of person(s)/entity(ies) determining the baseline:
Mr. Soeren Varming[12]
Managing Director
SV Carbon Sdn Bhd
609 Block E, Phileo Damansara I
9 Jalan 16/11 Off Jalan Damansara, 46350 Petaling Jaya
Selangor, Malaysia
Phone: + (6) 03 7665 0140
Fax: + (6) 03 7665 3799
Hand phone : +(6)019 262 7970
Email: sv@svcarbon.com Url: www.svcarbon.com

[12] The consultant 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:

>>
01/03/2007

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

>>
20 years

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

C.2.1. Renewable crediting period

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

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:

01/08/2008. The crediting period shall start after the registration of the project.

C.2.2.2. Length:

>>
10 years

SECTION D. Environmental impacts

>>

D.1. Documentation on the analysis of the environmental impacts, including transboundary impacts:

Under Malaysian Environmental Quality (Environmental Impact Assessment)(Prescribed Activities) Order 1987, projects involving the upgrading of existing wastewater systems are not listed as prescribed activities that are required to carry out an Environmental Impact Assessment. However, the installation of a boiler with stack emissions will require permission from the Department of Environment, Malaysia. The project developer will obtain the necessary approvals before commissioning and during operation of the project activity.

The negative environmental impact of this project is anticipated to be negligible. Potential negative impact is probably associated with the risk of explosion or leakage of methane collected. These could potentially create a safety risk and harm the surrounding environment. To mitigate such risks, the management will:

- ensure that suitable materials like thicker materials such as schedule 40 or 80 or stainless steel and proper welding joints are used;
- ensure proper design and operation, regular monitoring and maintenance of the system;
- take the necessary precautions to prevent activities within the area that could spark explosions like smoking and welding.

On the other hand, the positive environmental impacts of the project activity can be highlighted. In general, implementing such biogas to energy project brings positive impacts highlighted already in section B.5. Key positive impacts will include

- more efficient treatment, less land area required;
- reduced greenhouse gas emission;
- reduced odour and acid rain problems to surrounding and within the mill;
- promoting the use of renewable energy, cleaner exhaust compared to alternative such as the conventional biomass boilers or diesel generator set; and
- promoting better image on palm oil production technology.

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:

>>

Not applicable

SECTION E. Stakeholders' comments

>>

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

Kim Loong Power Sdn Bhd invited a total of 141 people, comprising Desa Kim Loong staff, suppliers of fresh fruit bunches (FFB), neighbouring estates and residents around the area (By invitation letters). Of that, 116 attended the meeting held on 8 January 2007 at the factory premises in Sook, Keningau, Sabah, Malaysia.

A briefing on the project was conducted by Dr. Gee Ping Tou (Project Coordinator) who also responded to the questions and feedback from the participants. The briefing was conducted in Bahasa Malaysia (Malaysian National Language) and translation into Dusun (a native language) was performed by Mr. Amin Eson. A translator (Ms Hazalin Risi) for another native language, Murut, was available but was found to be unnecessary. The meeting was video-recorded for documentation.

E.2. Summary of the comments received:

Participants were invited to seek clarification, ask questions or offer feedback. The discussion has been grouped according to several common themes that were raised.

Technical details. Several separate questions were asked related to the project details. These questions and the corresponding response were:

1. How is biogas being generated and separated? How long is the retention time at the anerobic digester?

   Dr. Gee explained that bacteria consumed POME as food and liberated biogas. Biogas is lighter than the digested liquid and the gas phase is separated from the liquid phase by density difference. Normally, 10 to 20 days of retention time is sufficient.

2. How to transport biogas to the boiler?

   The biogas is compressed at the anaerobic digester and transported to the boiler via stainless steel pipeline.

3. What is the operating temperature for bacteria at the anaerobic digester?

   There are two common types of bacteria, the mesophilic bacteria operate at lower temperature and the thermophilic bacteria operate at higher temperature. For this project, we anticipate that the operating temperature will be in between mesophilic and thermophilic, at around 43ºC.

4. If there is a leak, how far can the methane spread?

   If there is a leak, methane probably will cause more damage to the atmosphere (as it shall cause global warming) than the localized environment. The lateral spread for the leak is likely to be less than 200m radius. The damage to the localized environment is not going to be worst than the scenario before the project where all the methane is released into the atmosphere. Dr. Gee also informed the participants that under the project, it is required to monitor leakage in accordance with the monitoring plan.

5. What is the effect of excess oil entering the anaerobic digesters?

   Dr. Gee mentioned that small quantity of oil can be tolerated by the bacteria and the oil will serve as nutrients for bacteria. However, sudden loading with large amount of oil will cause upset for the bacteria, causing anaerobic digester to turn sour.

6. How much of electricity can be generated from biogas?

   Dr. Gee mentioned that each cubic meter of biogas can generate about 1.8 kWh of electricity.

A participant seek clarification on the global warming potential (GWP) of methane relative to carbon dioxide. He was confused that carbon dioxide cannot be burnt and yet methane has a GWP of 21.

Dr. Gee clarified that the project involved reduction of methane, which can be removed by combustion. GWP of 21 for methane means that the global warming effect of 1 ton of methane is equivalent to 21 tons of carbon dioxide, it is not referring to combustion of 1 ton of methane yielding 21 tons of carbon dioxide.

Uses of biogas. Two participants asked about the possible use of biogas by households, for example, as cheaper alternative to commercial cooking gas.

It was explained to them that biogas contains hydrogen sulphide, a component which is toxic to humans. Hydrogen sulphide must be removed before it can be safely use as household cooking gas. Hydrogen sulphide removal, building biogas storage tank and long pipeline to houses will be expensive and therefore it is more economical to be used as boiler fuel.

Safety and health aspects. Questions were asked about the safety of the staff exposed to biogas and whether palm oil mill pollution will cause infectious diseases to the surrounding residents.

Dr. Gee replied that hydrogen sulphide in the biogas is hazardous. The level of about 1,500-3,000 ppm is considered to be tolerable but can be improved and this is a common problem faced by palm oil mills. As such, the project could make the environment safer for the people living close to the factory. The project would remove the risks of exposure as the methane will be captured and used as biogas. Dr. Gee also mentioned that similar biogas can be found in fermentation process of organic compounds such as leaves in a damp forest.

Dr. Gee mentioned that the palm oil mills have existed for more than 35 years in Malaysia and so far he was not aware of any infectious diseases caused by palm oil mill operations.

Impact on FFB pricing and factors affecting FFB supply. A participant (smallholder) commented that the FFB price that he was paid was lower than that announced in the radio or newspaper for Peninsular Malaysia. He also added that the production costs in the Sook District are high due to higher transportation caused by the even topography. He asked whether the palm oil mill can offer FFB price same as that announced.

Dr. Gee mentioned that palm oil mills also are facing higher transportation cost in transporting CPO from oil mill to the refinery. FFB price are announced by Malaysian Palm Oil Board (MPOB) and the price fluctuate based on crude palm oil price which in turn fluctuate with supply and demand situations. The palm oil mill can consider paying slight higher price as compared to other palm oil mills in the same neighborhood, as the mill is currently underutilized, processing 210,000 t FFB per year, well below the rated capacity. Mr. Jason Wong (Manager of Desa Kim Loong Palm Oil Mill) added that the lower FFB price in Sabah is due to additional Sabah Government tax of 7.5% on crude palm oil.

The participant then asked whether the palm oil mill can help the smallholders by discussing the matter with State Government on reducing Government tax for crude palm oil or other means to push for higher palm oil prices.

Dr. Gee replied that the tax involved Government policy and is beyond the ability of the palm oil mill to assist them. Dr. Gee felt that palm oil prices are subjected to international supply and demand. Malaysian Palm Oil Promotion Council and the Government should make greater effort to promote palm oil, especially palm oil is traded well below the prices of soybean and rapeseed oil.

Smallholders asked whether the palm oil mill is willing to provide loan for them to buy fertilizer which in turn may provide better FFB and benefit the palm oil mill.

Dr. Gee mentioned that there are government incentives including low interest rate bank loan available for smallholders. Mr. Jason Wong added that the mill is willing to make advanced payment to regular FFB supplier.

A participant mentioned that he was informed during the last few days that many oil palm died suddenly in the Sook district due to certain disease and whether the palm oil mill can help them to treat the disease. He was worried that if all the oil palm died, the palm oil mill will not have any FFB to process.

Dr. Gee replied that he was not aware of sudden death of large patches of oil palm due to disease yet. The only notorious disease for oil palm that he knew of is the *Ganoderma*. Smallholders were advised to consult MPOB for technical assistance on oil palm diseases.

Biogas as boiler fuel. A staff enquired whether the use of biogas will affect the work of workers at the boiler station.

Biogas can be fed automatically into the dual fuel burner of the boiler, so the worker shall have slightly less work load but workers are still needed to feed the solid biomass fuel, therefore they are assured that their posts will not be redundant. Dr. Gee further mentioned that biogas is easier to be combusted than solid fuel and complete combustion shall have no visible smoke. This may help to reduce black smoke intensity of the boiler.

Water pollution. A local resident asked whether the operation of Desa Kim Loong Palm Oil Mill is polluting the Sook River.

Dr. Gee mentioned that the license issued to the palm oil mill is on land application and therefore the treated effluent is not discharging into Sook River.

Project status. Questions were asked on when the project can be implemented and who are carrying out similar projects in Malaysia.

Dr. Gee mentioned that this project shall be implemented commencing second half of this year. He also mentioned that the Kota Tinggi CDM project was one of the first CDM project on methane emission reduction approved by the Malaysian designated national authority and hopefully, the Desa Kim Loong project at Keningau will be the second one to be approved. Similar projects were carried out by Keck Seng and Sime Darby groups, the former used the biogas as fuel for boilers in the palm oil refinery whereas the latter failed in using biogas to operate gas turbine for generating electricity. The rest of the palm oil mills were not involved in methane emission reduction activities.

Project commercialization. A staff enquired whether Kim Loong Power Sdn. Bhd. can commercialized the CDM project by providing technology and services to other palm oil mills.

Dr. Gee commented that while it is technically possible as we have the technology. However, at the moment we may not have extra human resources to handle the external services.

CDM information. A District Officer in the Sook District commented while there are so many benefits to the environment, he has not heard of CDM projects. He would like to invite Dr. Gee to give seminar on CDM for the people in the Sook District.

Dr. Gee replied that it is more appropriate to approach Pusat Tenaga Malaysia (PTM) and Forest Research Institute of Malaysia (FRIM) as these two bodies are the national secretariats for CDM projects involving energy and forestry respectively, whereas we are limited to methane emission reduction only.

Impact on the environment. Several participants commented that the project has so many benefits to the environment, they hope that the project can be implemented as soon as possible.

Dr. Gee mentioned that the project needs to follow CDM application procedures and one of the requirements including the approval of this stakeholders' meeting. After which the project document design can be submitted for global stakeholders' comments, independent validation and approval by the national designated authority, and finally to the CDM Executive Board for registration.

A participant commented that since the project is so beneficial to the environment, whether it should be made mandatory to implement by the Government.

Dr. Gee mentioned that one of the requirements for CDM project is that it has to be a voluntary project. Any project required to be carried out by law is not eligible to be registered as CDM project. As the project involves high technology barrier and huge capital, income from CER is needed for the viability of the project. It is therefore not recommended to make similar project mandatory by law.

General observation

The participants accepted the benefits of the project and would like to see more similar projects to be undertaken. The participants were particularly happy with the better working environment. FFB suppliers were positive because of the company's commitment to offer them better premium for the fruits. There was also interest about other mills taking on this project because of the obvious benefits.

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

All questions were answered at the stakeholder meeting and no further follow up was required.

Annex 1

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Annex 2

INFORMATION REGARDING PUBLIC FUNDING

There is no public funding in this project.

Annex 3

BASELINE INFORMATION

CALCULATION OF SPECIFIC POWER CONSUMPTION PER TON FFB PROCESSED

Deleted: MONTHLY DATA OF FFB PROCESSED, POME GENERATION AND DIESEL CONSUMPTION FROM 2004 TO 2006

Year	Month	FFB (t)	Power produced	kWh/FFB	
2005	Jan	6,342.13	25790	4.07	
	Feb	6,367.74	25413	3.99	
	Mar	7,584.08	19713	2.60	
	Apr	9,629.76	19401	2.01	
	May	10,548.65	25258	2.39	
	Jun	10,311.35	21761	2.11	
	Jul	10,295.11	19890	1.93	
	Aug	12,220.88	24265	1.99	
	Sep	12,634.27	26223	2.08	
	Oct	14,783.93	20605	1.39	
	Nov	14,328.65	29282	2.04	
	Dec	11,683.07	35,741	3.06	2.47
2006	Jan	8,603.13	45282	5.26	
	Feb	10,531.29	38876	3.69	
	Mar	13,046.46	30850	2.36	
	Apr	16,130.03	42802	2.65	
	May	14,162.72	35187	2.48	
	June	14,536.64	41478	2.85	
	July	13,573.58	48477	3.57	
	Aug	14,021.68	52121	3.72	
	Sep	16,355.83	42534	2.60	
	Oct	18,680.68	49645	2.66	
	Nov	21,650.57	43506	2.01	
	Dec	17,273.65	53,703	3.11	3.08
2007	Jan	17,768.47	60096	3.38	
	Feb	12,506.80	40556	3.24	
	Mar	13943.33	44137	3.17	
	Apr	13888.56	55708	4.01	
	May	17923.79	28129	1.57	
	June	18587.28	38961	2.10	
	July	21561.55	37088	1.72	
	Aug	22162.34	38451	1.73	
	Sep	24871.01	74463	2.99	
	Oct	26198.14	23339	0.89	

Nov	27615.1	35386	1.28	
Dec	27793.61	23204	0.83	2.24
				Average kWh/tFBB
				2.60

Financial parameters and assumptions:

Price of carbon (EURO € /tCO_2e)		11
Exchange rate RM/EURO €		4.6
Project development costs (RM) • Modifications of the two open anaerobic tanks into enclosed ones, an overflow tank, pumps, compressors, waste fuel burners, flame arrestors, lightning arrestor, piping and fittings, a new boiler with dual fuel burner, steam turbine, electrical installation, gas sampling and monitoring equipments, housing structures for operation control room.		5,300,000
Estimated annual operating costs (RM)	Repair and maintenance	200,000
	Other administration expenses (Travel, stationary ect)	42,000
	Salaries and wages	150,000
	Consultancy fees (total)	400,000
	Land rental (total)	120,000
	Telecommunications payment	2,000
	Audit fee, secretary fee and others	50,000
	Utilities payment	20,000
Estimated revenues from biogas (RM) per year at full production		781,039

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Note:¶
<#>The Mill started with its production capacity 10 tph (tonnes per hour) of FFB. The maximum capacity was increased to 45 tph of FFB (equivalent to 330,000 t FFB per year) since July 2004.¶
<#>Average POME generation is 0.7 m^3 per tonne of FFB processed.¶
<#>Average diesel consumption is 1.6 liter per tonne of FFB processed (also equals to 0.0008585 toe per tonne FFB processed, with density of diesel 0.00085 tonne/Liter; energy content 1 toe per tonne of diesel).¶
¶

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Assumption:

Revenue:

1. Revenue from the value of biogas is 8.3 RM/GJ or 0.19 RM/Nm^3 (see below) For the sensitivity analysis a 50% higher value is used: 0.285 RM/ Nm^3
2. Revenue from carbon credit is taken up at EURO €11 (RM50.60) per MT reduction in carbon dioxide equivalent.

Expenditure:

1. Advances made at the beginning of year 1, repayments in year 2 and 3 are made progressively throughout the years.
2. Other administration expenses are projected at 2% on cash expenditure and revenue and include staff travel, stationary etc.
3. Repair and maintenance of plant is estimated at RM200,000 per year and will need to be spent after expiry of warrant at the end of year 2.
4. Consultancy fees of RM400,000 will be paid over 2 years.
5. Rental is RM12,000 per year which is assumed to be paid for 10 years in advance in year 1.

Tax:

1. Assuming pioneer status is granted. Tax exemption rate is 70% of statutory income for 5 years.
2. Income tax rate is assumed at 28%.

3. Assuming 1% of operating expenses (excluding depreciation) is non-deductible expenditure.
4. Capital allowance is assumed at 20% p.a., whilst initial allowance is 20%.

Value of biogas
The energy content of 1 Nm^3 of biogas is 0.023 GJ.

The biogas produced in the Keningau biogas plant will mainly be replacing biomass fuel in the existing boiler. To reach a value of the biogas it is thus necessary to establish value of the biomass fuel.

A paper by Ravi Menon[13], Malaysian Palm Oil Board, attempts to quantify the value of EFB as fertilizer and as fuel. (The valuation as fertilizer is very comprehensive, whereas the valuation for power is somewhat flawed since CAPEX is not taken into account – but that only leads to an overestimation of the fuel value). The paper leads to a value of the EFB of 14.4 RM/ton as fertilizer and 49.81 RM/ton as fuel. The paper quotes a lower heating value of the EFB of 6000 KJ/kg (or 6 GJ/t). This leads to a value of 2.5 RM/GJ (14.4/6) to 8.3 RM/GJ (49.8/6).

The base case for the financial calculations is that the biogas will only replace biomass fuel and taking the higher of the numbers from Ravi Menon this leads to a value of 8.3 RM/GJ or 0.19 RM/Nm3 (8.3*0.023).

Annex 4

MONITORING INFORMATION

Monitoring:

Monitoring will be according to AM0022 as follows:

The monitoring methodology involves monitoring of the following parameters after project implementation: The volume and COD concentrations of organic wastewater into the digester and at the outlet.

For determining project emissions:

- COD concentrations in discharged effluent from digester to estimate CH_4 emissions in the project case.
- Biogas and CH_4 into the boiler. The amount of CH_4 is obtained by monitoring the flow rate into the boiler. CH_4 content of the biogas entering the boiler is measured. There is also a need to measure the CH_4 content in the stack.
- Fugitive CH_4 emissions from biogas at the digester outlet and at the electricity generator inlet. The amount of fugitive CH_4 is obtained by monitoring the biogas flow rate at the digester outlet, the flare inlet and the boiler fuel inlet. The biogas leakage is not expected to occur in the boiler.
- CH_4 content at the boiler inlet and outlet. The amount of CH_4 entering the boiler will be monitored so that a comparison can be made with the emission reduction amount calculated *ex*

[13] Ravi Menon: Empty Fruit Bunches evaluation

ante. Each of the three minor emission sources (emissions associated with fossil fuel use; fugitive CH_4 and stack gas; CH_4) is considered to be negligible. However, they will be monitored and an emission source will be included in the project emission calculations once it is considered significant, thus contributing to more than 1% of the annual amount of CERs.

The methodology allows for the monitoring of both the project and baseline scenario emissions. This occurs through use of project specific data (where appropriate in a project specific situation) as direct indicators of the actual baseline. The main elements to be monitored include:

- Fugitive methane through assessment of organic material flows through project and the baseline system
- On-site heat generated from the biogas collected in the anaerobic treatment facility
- Subsequent electricity generated from the steam produced from the anaerobic treatment facility and consumed on-site
- Inefficient biogas combustion emissions in project: emissions arising though inefficient destruction of biogas in the boilers and emergency flares will be quantified through assessing the efficiency of biogas destruction during equipment O&M cycles
- Biogas leakage in project: through leaks in the pipeline during transportation of biogas, or its production in anaerobic digesters

References

Borja, R., Banks, C.J. and Sanchez, C., 1996. *Anaerobic treatment of palm oil mill effluent in a two-stage up-flow anaerobic sludge blanket (UASB) system*. Journal of Biotechnology, 45: 125-135.

Chua, C.K., Ong, K.P., Zainuriah, A., and Zulkornian, A.H., 2006. Benefits of Bio-Compost to the Estate Environment. Paper for *Seminar on Available Technology to Achieve Zero Discharge/20 ppm BOD Water Course Discharge of Treated POME*, Bangi, 3 April 2006.

Department of Environment Malaysia (DOE), 1999. *Industrial Processes and the Environment (Handbook No. 3) – Crude Palm Oil Industries*.

Department of Industrial Works (DIW), 1997. Environmental Advisory Assistance for Industry: *Environmental Management Guideline for the Palm Oil Industry*.

Eco-Ideal Consulting Sdn. Bhd. (Eco-Ideal), 2004. MEWC/PTM/DANIDA: *Study on Clean Development Mechanism Potential in the Waste Sectors in Malaysia*. Unpublished.

Economic Planning Unit (EPU), 2006. *Ninth Malaysian Plan 2006-2010*.

International Law Book Services (ILBS), 2004. *Environmental Quality (Prescribed Premises) (Crude Palm-Oil) Regulations 1977* in: Environmental Quality Act 1974. Kuala Lumpur, Direct Art Company, 49-62.

IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories.

Jaafar, A.B and Tong, S.L. 2004. *Waste to energy: Methane recovery from anaerobic digestion of POME.* Malaysia Energy Centre Energy Smart Issue 0014.

Ma, A.N., 1999. Management of palm oil industrial waste in Malaysia. Paper presented at the *Seminar on integrated waste management in Sarawak*. Kuching, 28-29 July 1999.

Ma, A.N., 2002. Carbon credit from palm: Biomass, biogas and bio diesel. MPOB: Palm Oil Engineering Bulletin. 24-26.

Ma, A. N., Cheah, S. C. & Chow, M.C., 1993. Current status of palm oil processing wastes management in waste management in Malaysia: Current status and prospects for bioremediation. pg 111-136

Ministry of Science, Technology and Environment (MOSTE), 2000. *Malaysia Initial National Communication*.

Radhakrishnan, 2006. Sindora Composting Plant. Presentation at *Seminar on Available Technology to Achieve Zero Discharge/20 ppm BOD Water Course Discharge of Treated POME*, Bangi, 3 April 2006.

Shamsudin, A.L., The way forward: the need for better management of palm oil mill waste. Presentation at *Seminar on Available Technology to Achieve Zero Discharge/20 ppm BOD Water Course Discharge of Treated POME*, Bangi, 3 April 2006.

Shirai, Y., Wakisaka, M., Yacob, S., Hassan, M.A., and Suzuki, S., 2003. *Reduction of methane released from palm oil mill lagoon in Malaysia and its countermeasures*. Mitigation and Adaptation Strategies for Global Change, 8: 237–252, 2003.

Suki, A. and Wok, K., 2006. Composting at Golden Hope Plantations Berhad. Presentation at *Seminar on Available Technology to Achieve Zero Discharge/20 ppm BOD Water Course Discharge of Treated POME*, Bangi, 3 April 2006.

Yeoh, B.G. 2004a. A Technical and Economic Analysis of Heat and Power Generation from Biomethanation of Palm Oil Mill Effluent. Paper presented at the *Electricity Supply Industry in Transition: Issues and Prospect for Asia Conference,* Thailand 14-16 January 2004.

Yeoh, B.G., 2004b. Energy Recovery From Wastewater Treatment: A Case study in the Biomethanation of palm oil mill effluent. Presentation at *Brunei Darussalam Cogeneration Week 2004*, Bandar Seri Bagawan, 23-24 November 2004.

Pusat Tenaga Malaysia (PTM), 2000. *Feasibility on Grid Connected Power Generation Using Biomass Cogeneration Technology*. Selangor.

United Nations Framework Convention on Climate Change (UNFCCC), 2005. *Tool for the Demonstration and Assessment of Additionality (Version 03)*. CDM-Executive Board Meeting 29.

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