PROJECT DESIGN DOCUMENT FORM
FOR CDM PROJECT ACTIVITIES (F-CDM-PDD)
Version 04.1

PROJECT DESIGN DOCUMENT (PDD)

Title of the project activity	Methane Capture and On-site Power Generation Project at Sungai Kerang Palm Oil Mill in Sitiawan, Perak, Malaysia
Version number of the PDD	3
Completion date of the PDD	04/07/2013
Project participant(s)	(i) Sungai Kerang Development Sdn Bhd; (ii) Mercuria Energy Trading SA (Switzerland)
Host Party(ies)	Malaysia
Sectoral scope and selectedmethodology(ies)	Scope 13 – Waste handling and disposal Methodology – AM0022 version 4.0
Estimated amount of annual average GHG emission reductions	78,583

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

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Malaysia is the largest palm oil exporter in the world with a total of 4 million hectare of palm oil plantations and around 400 palm oil mills spread over the country. The palm oil sector provides a very important element in the rural economy of Malaysia by providing a very significant source of employment – not only in agriculture, but also in down stream industries like mills and refineries.

The palm oil mills process Fresh Fruit Bunch (FFB) into the main products Crude Palm Oil (CPO) and palm kernels. In the process a number of waste streams are produced including solid biomass waste (Empty Fruit Bunches, mesocarp fibre and shell) and waste water or Palm Oil Mill Effluent (POME).

The POME stems from the steam used for sterilisation of the FFB and hot water for dilution. In recent years a further waste water stems from the juice squeezed from moisture reduction of empty fruit bunch. This process has been added to increase the output of palm oil, but it also increases the COD content in the POME. For every tonne of FFB processed at the mill, approximately 0.6 - 0.8 m^3 of POME is produced. The POME has a high content of organic matter with levels of Chemical Oxygen Demand (COD) of 50,000-90,000 ppm. Conventionally the POME is treated in an open lagoon system using anaerobic and facultative ponds. Methane is formed during the anaerobic conditions in the ponds and emitted directly to the atmosphere.

The Sungai Kerang Palm Oil Mill has the capacity to process an average of 80 metric tons of Fresh Fruit Bunches (FFB)/hour. The annual availability of FFB at the mill varies according to the yield at the oil palm plantations and quantity purchased. The mill is expected to process 500,000 metric tons of FFB/year during the crediting period. Solid biomass waste from the milling process such as mesocarp fibre is utilised for energy production for own consumption whereas kernel shells are mainly sold. Empty Fruit Bunches (EFB) are mainly incinerated, and deposited in the landfill adjacent to the mill. The operation at the mill also results in approximately 0.6 m^3 of POME/ton of FFB processed, generating approximately 300,000 m^3 of wastewater per year.

The wastewater from the mill is treated through the conventional ponding system including cooling, anaerobic, facultative, maturation and polishing lagoons. The existing open lagoon system includes the application of 1 cooling pond, 3 anaerobic ponds with an average depth of 5.3 metres (Pond No. 2,3 & 4) followed by 2 facultative ponds (Pond No. 5&6).

POME from the mill will be pumped into the cooling tank using 3 units of effluent feed pumps of 30hp (23kW) each. From the cooling tank, the effluent will be channelled into remaining effluent treatment system via gravitational flow. The effluent treatment system also consist of 2 surface aerators used in each of the facultative ponds, and sequential batch reactor (SBR) that consumes approximately 188kW of power.

Final effluent is channelled through 3 maturation ponds (Ponds No. 8, 9 & 10) for a retention period of 17 days before being pumped into a Sequential Batch Reactor (SBR) Tank. The final effluent is channelled to a final polishing pond (Pond No.11) before being discharged into open water course.

Under the baseline scenario, COD level in POME is reduced up to 95% in the anaerobic system. Based on 6-days continuous study (for the period of study between 5^{th} – 21^{st} October 2007), the incoming POME COD is an average of 93 kg/m^3.The COD is reduced to 2,000 kg/m^3 (average test results on 8^{th} and 16^{th} April 08) before entering to aerobic ponds (aeration pond, settling basins & maturation ponds) where content of organic material is further reduced to below 20 mg/l BOD before being released to the water course

Presently the mill is subjected to the Environmental Quality Regulations (1978) Palm Oil Effluent Discharge Standard. The quarterly reports submitted to the Department of Environment (DOE) show that the mill has been in general compliance with the licensed effluent discharge standard. The existing pond system is thus able to treat the POME to comply with the Malaysian environment requirements.

- The Project activity involves the treatment of Palm Oil Mill Effluent (POME) by installation of a closed continuous-flow stirred tank reactor (CSTR) anaerobic digester plant and a biogas capture system at the Sg. Kerang Palm Oil Mill. Biogas captured in the closed anaerobic digester will be utilized for on-site electricity and steam generation. By capturing and utilizing biogas, the Project activity will eliminate methane emissions from the existing open lagoon based system. The Project activity will also contributing to further efficiency in utilisation of biomass resources by allowing the palm oil mill to sell bio mass fuel to third parties and displace carbon emissions from the Peninsular Malaysia electricity grid by reducing the need for import of electricity to the mill.

Measures that will be undertaken in the Project activity include:

- Replacing the existing anaerobic ponds with closed anaerobic digesters system, inclusive of a sludge removal facility.
- Capturing and collecting the biogas (a mixture of 62.5% methane, 37% carbon dioxide and trace amount of hydrogen sulphide) produced from the closed anaerobic digesters;
- Retrofitting of the two existing biomass boilers in the palm oil mill to utilise the biogas for steam production; and
- Establishing an Enclosed flare for flaring of any excess biogas (started operation on 18/5/2010).

The Project activity will contribute to sustainable development of Malaysia in the following three areas:

Environmental benefits

- Reducing air pollution from anaerobic treatment of the POME in open ponds. The emissions to air include methane, volatile fatty acids and hydrogen sulphide;
- Reducing unpleasant odour caused by treatment of high strength organic wastewater at open ponds; and
- Reducing water pollution as the new biogas system will provide a better controlled and more efficient process for removal of the organic content in POME.

Economic benefits

- Utilization of biogas as a renewable energy source in Malaysia;
- Contributing to further efficiency in utilisation of biomass resources by allowing the palm oil mill to sell bio mass fuel to third parties;
- Decreasing the country's dependence on imported and fast depleting fossil fuels; and
- Savings in FOREX due to import of fuels.

Social benefits

- Creating new jobs for local population; and
- Improving the technical skills of staff in the operations and maintenance of the new anaerobic digester system.

The biogas plant will contribute to transfer of technology/improvement of technology in the following ways. The technology employed for the biogas plant is based on the principles of continuous-flow stirred-tank reactor (CSTR) system incorporating the contact process for anaerobic digestion. The technology was adapted from published international literature sources and perfected locally for palm oil mill effluent treatment. The technology represents a significant improvement over the open anaerobic lagoon system commonly adopted by the palm oil sector. The proposed project involves technology transfer from Annex I parties and/or other non-Annex I parties through the supply of the following types of advanced equipment and instrumentation required for the anaerobic digester system: (i) Various types of effluent and biogas pumps, regulators and valves; (e.g. from Switzerland, Denmark or Germany); (ii) Flow meters for effluent and biogas measurements; (e.g. from Germany); and Biogas safety equipment: flow control and shut-off valves, flame arrestors, flame sensors, thermocouple; (e.g. from KSPC, South Korea or Varec, USA).

Biogas plants developed in industrial countries are typically twice as expensive as locally manufactured plant. This price differential makes the use of biogas plant from industrialised countries prohibitive in the palm oil industry – even if CERs can be claimed for the reductions in methane emissions. There is thus a need to encourage local adaptation of the biogas technology and to allow the cost reductions necessary for the spread of the technology in the palm oil sector.

A.2. Location of project activity
A.2.1. Host Party(ies)
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Malaysia

A.2.2. Region/State/Province etc.
>>
Perak

A.2.3. City/Town/Community etc.
>>
Sitiawan

A.2.4. Physical/Geographical location
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The project activity will be located at Sungai. Kerang Palm Oil Mill situated at 5th Km, Jalan Gelong Pepuyu, Bota, 32000, Sitiawan, Perak. (4°20'12"N 100°50’06”E)is a small town south west of the state of Perak. The new anaerobic digester will be situated at the present site for anaerobic ponds.

The following shows the map location of the project activity

Figure A.1.: Location map of the project site

A.3. Technologies and/or measures

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System design

The technology to be employed by the project activity consists of a highly efficient closed tank anaerobic digester system for the recovery of biogas from the treatment of POME. This closed anaerobic digester technology will apply the Continuous Flow-Stirred Tank Reactor (CSTR) approach with build-in sludge return. Good mixing is ensured through the CSTR approach thus preventing solid build-up and scum formation.

The biogas system includes four steel tanks with fixed roof with a size 3,700 m^3 each and one tank of 3,000 m^3 with floating roof. The floating roof feature will enable the storage of biogas, thus balancing the biogas flow when it is being utilized. The system also includes a sludge sedimentation tank and sludge return system for maintaining an acceptable level of sludge in the digester tanks.

The treated effluent after the digester tanks will be pumped to a holding tank with built-in aeration for about one day. The aerated effluent will be pumped to a clarifier where the settled sludge will be removed and sent to the disposal site. The clarified effluent will be directed to the aerobic lagoons for further treatment. The COD in the clarified effluent is expected to be about 3,000 mg/l, as a conservative value. The clarified effluent will be directed to the aerobic lagoons for further treatment before discharge to the nearby river.

The captured biogas is pumped through a pipeline delivery system to the existing biomass boilers. The power generated by the steam turbine from the biogas will reduce usage of biomass in the boiler and create extra savings from sales of saved biomass. The power generated will contribute to other on site power consumption, but will not be exported to the grid due to barriers against grid connection of small scale power projects.

Both of the existing biomass boilers will be retrofit with burners for the biogas. The boiler will produce steam for use in the palm oil mill and for the steam turbine for further electricity for use on site. The fibre previously used as fuel will be sold for use off site.

The specific biogas technology employed in the project is developed in Malaysia on the basis the 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 the 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, of benefit to both the local environment and the global climate.
- The biogas system will contribute to promoting renewable energy in Malaysia

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

In summary, the local adaptation of a globally available technology can be seen as the final stage of technology transfer[1].

Process design

[1]IPCC 2000 : Special report : Methodological and technological issues in Technology Transfer.

Pre-treatment of POME is necessary before it is channelled to the closed anaerobic digester. Raw POME is firstly channelled through the existing to a de-oiling tank to ensure minimal oil gets into the anaerobic digester.

This process is followed by the existing cooling and acidification pond before POME is pumped to stainless steel feeding tanks and distributed uniformly to four units of anaerobic digester tanks. 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)[2] while biogas containing CH_4 concentration of 60-65% (Ma 2002; Yeoh 2004a)[3] can be achieved.

As conservativeness, the CSTR digester system is capable of achieving 80% treatment efficiency or better in terms of anaerobic conversion and removal of COD input into the system. A further 15% of COD remaining in the sludge is mainly in the form of wasted anaerobic bacteria and will be removed from the digester system and dispose at the disposal site within the palm oil mill.

The anaerobic digestion is a multistage biochemical process performed on many different types of organic material. The digestion occurs in three basic stages. In the first stage complex organics, proteins, lipids and carbohydrates are broken down into soluble fatty acids, alcohols carbon dioxide and ammonia.

In the second stage the products of the first stage are converted into acetic acid, propionic acid, hydrogen, carbon dioxide, and other low molecular weight organic acids.

In the third stage two groups of methane forming bacteria go to work. One group of bacteria converts hydrogen and carbon dioxide to methane. Another group converts acetate to methane and bicarbonate. Both groups of bacteria are anaerobic.

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

Technical specifications to ensure no leakages

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. The followings are measures to be undertaken:

1. The fabrication and installation of the digester tanks, of both the fixed-roof and floating-roof types, 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 fixed-roof and floating-roof tanks with the liquid seal 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.

[2]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.

[3]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.

Test reports in accordance with the standard procedures will be obtained. During operation, the normal pressure of the biogas in the digester tank is expected to be in the range of 120 – 200 mm water column. 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.

2. The piping system and biogas pipeline will be fabricated and installed following strictly the required Technical Specifications and Standards similarly. After fabrication and installation, including the necessary pressure gauges, the pipeline will be pressure tested and check for leaks along the pipeline as per the standard procedures for the test. Any connection or welding defects shall be rectified immediately. A test report in accordance with the standard procedures will be obtained from the testers.

Training on operation and maintenance of the Plant

The contractor for the Plant shall provide necessary on the job training for the plant personnel on the operation and maintenance of the plant, inclusive of both the closed-tank CSTR anaerobic digester system and the biogas-fired boiler power generation plant. The personnel for the training shall include engineers, supervisors, technicians and operators assigned to the operation and maintenance of the plant. The training shall cover all aspects of the operational principles, procedures, service and maintenance techniques and schedule. Training on the monitoring requirements will be elaborated in the section of the PDD on monitoring plan. The proposed on the job training will be for a duration of five working days during the commissioning period. In addition, the project participant intends to engage the services of the contractor to provide key personnel for the operation and maintenance of the biodigester for at least an initial period of three months

The on the job training and contract services of the contractor will ensure the performance of the biodigester will be able to meet the specifications set in the output of the biogas and the power generation.

A.4. Parties and project participants

Party involved (host) indicates a host Party	Private and/or public entity(ies) project participants (as applicable)	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
Malaysia (host)	Private entity: Sungai Kerang Development Sdn Bhd	No
Switzerland	Private entity: Mercuria Energy Trading SA	No

A.5. Public funding of project activity

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There is no Public Funding involved in this project.

SECTION B. Application of selected approved baseline and monitoring methodology

B.1. Reference of methodology

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1. AM0022: Avoided Wastewater and On-site Energy Use Emissions in the Industrial Sector (Version 04, December 2006);

2. Tool for the demonstration and assessment of additionality (Version 03, February 2007).

3. Tool to determine project emissions from flaring gases containing methane (Annex 13, EB 28, 15 December 2006)

B.2. Applicability of methodology
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AM0022 (version 04) is applicable to the project activity as methane is captured from the anaerobic treatment of POME, which is a wastewater of high organic loading. Methane/biogas captured will be utilised for on-site heat and power generation.

The applicability conditions of AM0022compared to the project activity is shown in Table B.1.:

Applicability Criteria of AM0022	AM0022Project conditions
Project is implemented in existing lagoon-based industrial waste water treatment facilities for wastewater with high organic loading.	The project activity will be implemented at the current waste water facilities which treat POME, a waste waster with a high organic loading (COD level of POME entering the open ponds is approximately 75,000 mg/l).
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.	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. Based on the study by Yacob *et al.*, 2006[4], an average of 0.238 kgCH_4/kgCOD was emitted from anaerobic pond treatment of POME. 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 where the improvement will be by replacing the existing anaerobic ponds with a closed anaerobic digester system.
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 explained 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 existing open anaerobic ponds are in average of 5.27 m in depth. The project will replace the ponds with 4 units closed anaerobic digester tanks of 12.8 m depth each.

[4]S. Yacob et al. / Science of the Total Environment 188 366 (2006) 187–196Baseline study of methane emission from anaerobic ponds of palm oil mill effluent treatment

Applicability Criteria of AM0022	AM0022Project conditions
The temperature of the wastewater in the anaerobic lagoons is always at least 15˚C.	The temperature of the wastewater fed into the open anaerobic ponds 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 is expected to exceed 15˚C.
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 captured will be utilised for on-site heat and power generation. Only if excess, will biogas be flared.

<table>
<tr><th>Applicability Criteria of AM0022</th><th>AM0022Project conditions</th></tr>
<tr><td>Heat and electricity needs per unit input of the treatment facility remain largely unchanged before and after the project.</td><td>There will be no significant change to the heat and electricity requirements in the treatment facility before and after the project. Heating is not required for closed anaerobic digesters as the system will be operated at mesophilic conditions. Only a small amount of electricity is needed for the compressors and a gas pump.

Baseline Power consumption for effluent treatment
<table>
<tr><th>Component</th><th>Units</th><th>Total Power</th></tr>
<tr><td>Effluent Feed Pumps</td><td>3 x 30hp</td><td>69kW</td></tr>
<tr><td>Aerators & Sequential Batch Reactor</td><td>4 units</td><td>188</td></tr>
<tr><td colspan="2">Total Power consumption</td><td>257</td></tr>
</table>

Project Power consumption for effluent treatment
<table>
<tr><th>Component</th><th>Total Power</th></tr>
<tr><td>Effluent Feed Pumps (New)</td><td>30 kW</td></tr>
<tr><td>Aerators & Sequential Batch Reactor (Existing)</td><td>188 kW</td></tr>
<tr><td>Biogas plant (Pumps for sludge return system, holding tank, biogas and built in aerators)</td><td>100 kW</td></tr>
<tr><td>Total Power consumption</td><td>318 kW</td></tr>
</table>

Net increase in power consumption = Total Project Power consumption – Baseline Power consumption

= 318 kW – 257kW = 61 kW or 24%

In the baseline the total power consumption of the waste water treatment system is 257 kW. The power is used for the aeration in the aerobic ponds, for the SBR (Sequential Batch Reactor) and for three pumps of 30hp (23kW) each (i.e. a total of 69 kW), running 24 hours a day is used to pump POME to the anaerobic ponds.

The new treatment facility requires 318 kW of electricity including 188kW from the existing aerators and SBR and 130kW[5] of electricity from the new plant. In the new plant, 30kW will be used for effluent feed pumps and remaining</td></tr>
</table>

[5] Quotation No AQS-NNH/07/Q152 (Rev 2) pg 12/22

Applicability Criteria of AM0022	AM0022Project conditions
	100kW for pumps in the sludge return system, holding tank feed, biogas transportation in the biogas pipeline and built in aerators for the biogas tanks. The existing pumps will be replaced and the net increase in power consumption will thus be 61 kW or 24%. The approximate input to the treatment plant is 800 m^3/day. In the baseline, the power consumption for effluent treatment is 257kW/800m^3 = 0.321kW/$m^{3.}$ In the project , the power consumption for effluent treatment is 318kM/800m^3 = 0.398 kW/$m^{3.}$ Therefore, additional electricity would be only 0.077 kW/m^3. The electricity is generated onsite and based on biomass – in the project case also biogas - and there are thus no additional GHG emissions due to the electricity consumption. Therefore heat and electricity needs per unit input of the treatment facility remain largely unchanged before and after 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 will be measured or estimated and recorded. Clear and specific sampling locations for POME inlet and outlet sampling have been identified.

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

B.3. Project boundary

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The main sources of greenhouse gas emissions in the baseline are CH_4 from the open anaerobic ponds and CO_2 from import of electricity from the grid. During the implementation of the project activity, greenhouse gas emissions are expected from incomplete combustion of biogas in the biomass boilers. During situations where biogas supply is in excess, there may be some project emissions from incomplete combustion in the flare.

With implementation of the anaerobic digesters, the existing anaerobic ponds will no longer be used. All the POME will be channelled into the new anaerobic digester tanks and discharged into existing aerobic ponds, which, is outside the baseline boundary. Therefore, there is not expected to be any fugitive methane emission from existing lagoon system. The existing anaerobic ponds will be decommissioned but maintained until the biogas system is fully commissioned and running.

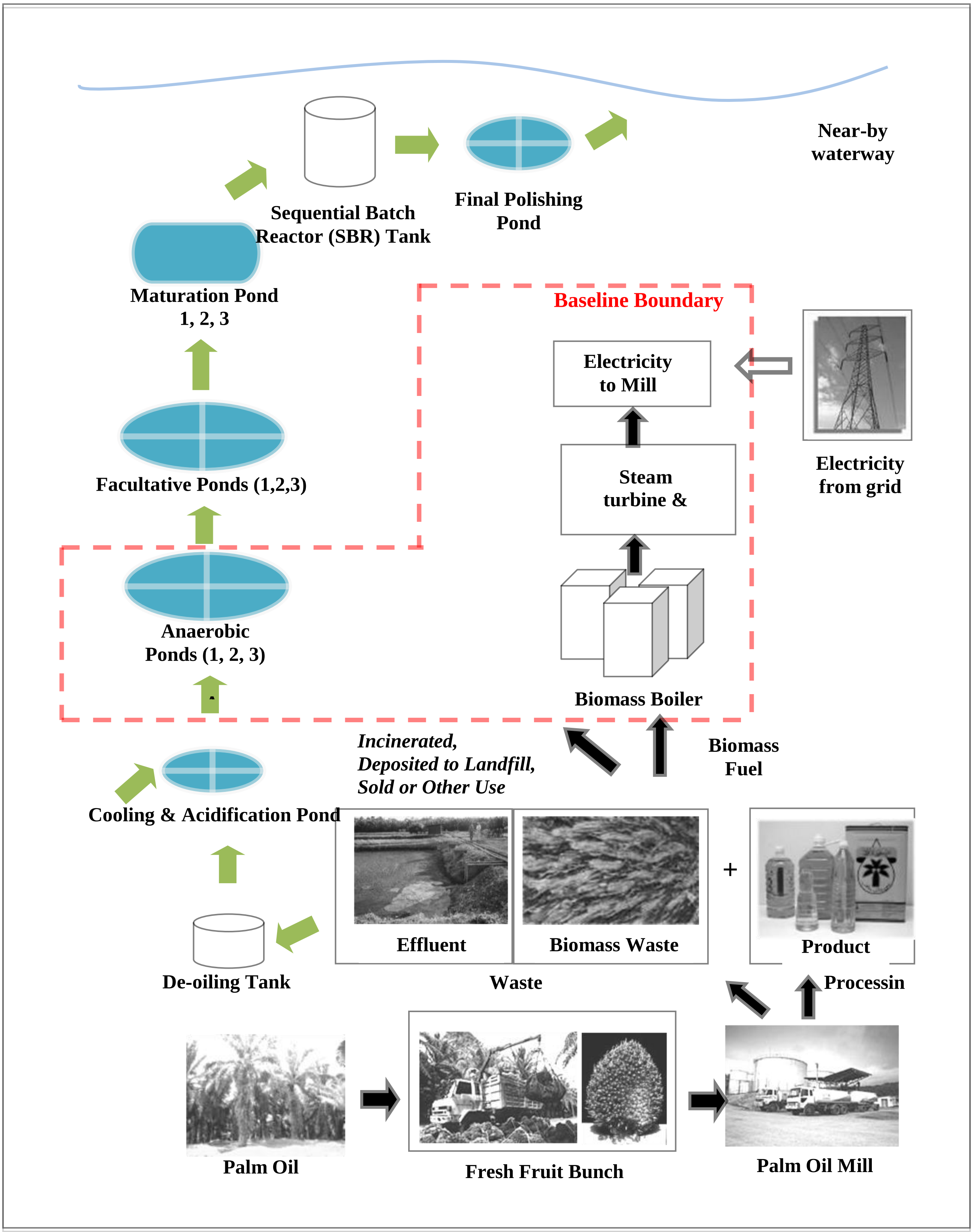

Figure B.1. : Baseline Boundary

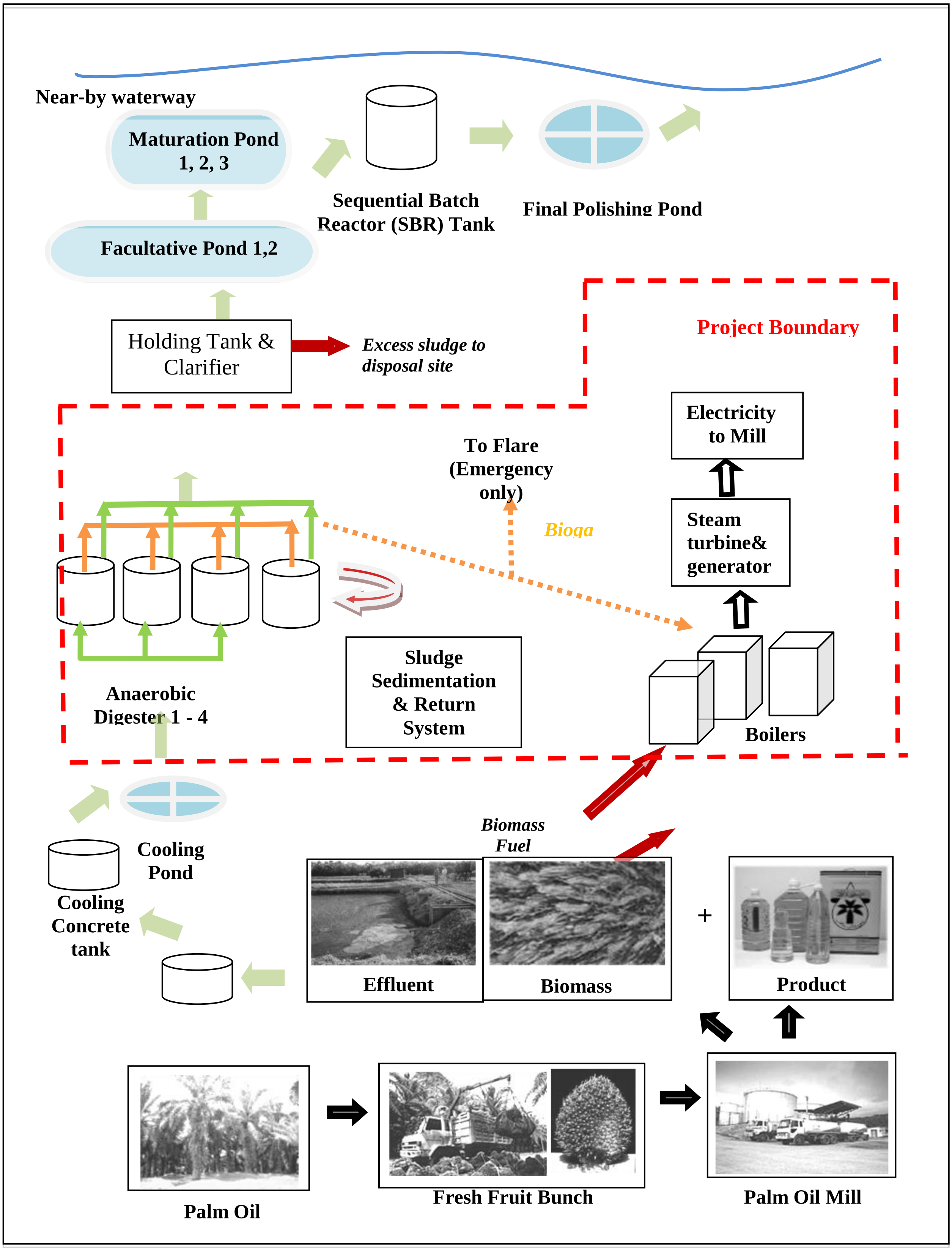

Figure B.2. : Project Boundary

Source		GHGs	Included?	Justification/Explanation
Baseline scenario	Anaerobic ponds	CO_2	No	Emissions originating from decomposition of organics matter are considered carbon-neutral
		CH_4	Yes	Emissions from open anaerobic ponds is the main source of GHG emissions in the baseline
		N_2O	No	Excluded for conservativeness
	Power from the grid	CO_2	Yes	Emissions from use of electrical power from the grid are included in the baseline
		CH_4	No	Excluded for conservativeness
		N_2O	No	Excluded for conservativeness
	Fossil fuel use for boiler start-up	CO_2	Yes	CO_2 emission from burning of fossil fuel during start up of boiler is considered a source of GHG emission in the baseline
		CH_4	No	Excluded for simplicity – expected to be minimal
		N_2O	No	Excluded for simplicity – expected to be minimal
Project scenario	Closed anaerobic digester	CO_2	No	Emissions originating from decomposition of organics matter 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[6] – See Section A. 4.3 for details
		N_2O	No	Excluded for simplicity – expected to be minimal
	Biomass boiler	CO_2	No	CO_2 emission based from biomass is considered carbon neutral
		CH_4	Yes	Emissions from incomplete combustion of biogas
		N_2O	No	Excluded for simplicity – expected to be minimal
	Flare system	CO_2	No	CO_2 emission based from biomass is considered carbon neutral
		CH_4	Yes	Emissions from incomplete combustion of biogas in flare system are only expected in emergency situations
		N_2O	No	Excluded for simplicity – expected to be minimal
	Emissions from disposal of sludge	CO_2	No	CO_2 emissions from decomposition of organic matter is not accounted (carbon neutral).
		CH_4	Yes	Included due to possible methane emissions from sludge at the disposal site.
		N_2O	Yes	Included to account for nitrous oxide emissions from sludge containing nitrogen.
	Biogas System	CO_2	No	CO_2 emission based from biomass is considered carbon neutral
		CH_4	Yes	Fugitive emissions from the enclosed tank digesters and the piping of the biogas are expected to be negligible
		N_2O	No	Excluded for simplicity – expected to be minimal
	Fossil fuel use for boiler start-	CO_2	Yes	CO_2 emission from burning of fossil fuel during start up of boiler is considered a source of GHG emission in the project boundary.

[6] 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

	up	CH_4	No	Excluded for simplicity – expected to be minimal
		N_2O	No	Excluded for simplicity – expected to be minimal
	Anaerobic Ponds	CO_2	No	Excluded for simplicity . Anaerobic ponds will no longer be used once the biogas system is commissioned.
		CH_4	No	Excluded for simplicity . Anaerobic ponds will no longer be used once the biogas system is commissioned.
		N_2O	No	Excluded for simplicity – expected to be minimal

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

Adding biogas as extra fuel source will reduce the need for fossil fuel and emission reduction is not claimed from fossil fuel use in baseline. Fossil fuel is only used during start up of boiler; therefore the use of fossil fuel is excluded to be conservative.

B.4. Establishment and description of baseline scenario
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The steps to demonstrate that the current practice of treating POME in open pond based system is the project baseline are identified and explained below.

Step 1: List a range of potential baseline options
Five options are identified as plausible alternatives in determining the project baseline:

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

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

Technologies and treatment methods for POME digestion mentioned in Step 1 may seem attractive but face barriers for their implementation. These barriers include technological, financial, social barriers and barrier related to business culture. Legal barrier is an absolute barrier as illegal options cannot be considered in the baseline and therefore will not be discussed further.

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

Table B.3.: Potential of significant barriers

The main types of barriers for project implementation and their significance are discussed below:

1) Legal Barrier

The legal barrier is an absolute barrier in the sense that illegal barrier cannot be the baseline.
Option 1 : *Direct release of POME to nearby water body*

It is not legal in Malaysia to discharge POME directly into water bodies in Malaysia. 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. 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. This legislation is described in detail in the "Environmental Quality Act, 1974 , Environmental Quality (Prescribed Premises) (Crude Palm Oil) Regulations 1977**.

Option 2 : *Installation of new treatment system (activated sludge or filter bed type treatment)*

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.

Option 3:Continuation of the current situation (business as usual)

Continuation of the current open pond systems comply with Malaysian legislation, so there is no legal barrier to the business as usual.

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 this option.

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. Therefore, there is no legal barrier to this option.

2) Technological barrier

This barrier is one of the most significant barriers. The technological barriers can include issues related to operation, maintenance and availability of technical skills to implement the different alternatives.

Option 1 **:** *Direct release of POME to nearby water body*

Technological barrier is not applicable for this option as there is an absolute legal barrier for this option – and that all the other barriers become irrelevant

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. There are 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.

Option 3: Continuation of the current situation (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 85% 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.

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 boilers using the biogas. This gives reluctance in the palm oil industry to enter into biogas projects.

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[7].

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).[8] 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

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 also requires 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

3) Financial barrier

[7] Dr. Jason Yapp and Dr. Adrianus Rijk: CDM potential for commercialisation of the Integrated Biogas Systems (p4)

[8]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.

Financial barrier is also a significant barrier in implementation of the proposed project activity. This combined with technological barrier has been one of the main reasons contributing to the lack of interest in the biogas technology in palm oil industry in Malaysia. The capital and operation costs of a biogas technology are significantly higher than the costs of implementing open ponds system. Income generated from the sales of CERs could significantly improve the financial attractiveness of biogas technology (please see Section B.5 for financial results of including CERs in the cash flow). The general reluctance to invest in non-core activities if not required by law is also a financial barrier. This is partly related to the fact that there are more attractive, competing investments in the sector.

Option 1 : Direct release of POME to nearby water body

Financial barrier is not applicable as this option as there is an absolute barrier for this option – and that all the other barriers become irrelevant

Option 2 : Installation of new treatment system (activated sludge or filter bed type treatment)

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.

Also, such systems require constant monitoring by operators and supply of power to ensure continuous operations. As palm oil mills only operate 24 hour shifts during high fruit season, such a system would require the mills to hire extra staff to monitor 24 hours and also generate extra power for fossil fuel source during the non operation of the mills.

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 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 investment costs 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.

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 to find local investors for biogas plant in Malaysia[9].

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

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.

[9] *MEWC/PTM/DANIDA Report "Study on Waste Sectors in Malaysia ,PTM (Pg 102 – 109)"*

The mill is implementing a small scale CDM project for composting, adapting new technology using EFB and concentrated sludge from biogas plant for its EFB landfill management. This project also requires CDM to be financially viable.

4) Social barrier

Research has been conducted by local institutions and pilot plants set up for alternative POME treatment method but full scale implementation of new technologies has not been well-received due to perceived risks and high costs involved.

Option 1 : Direct release of POME to nearby water body
Social barrier is not applicable as this option as there is an absolute legal barrier for this option – and that all the other barriers become irrelevant

Option 2 : Installation of new treatment system (activated sludge or filter bed type treatment)
This option faces minor social barrier due to the lack of understanding of the technology by the host country / industry.

Option 3: Continuation of the current situation (business as usual)

This option does not face any social barrier as open pond system is the most common waste water treatment system for palm oil mills in Malaysia, whereby 85% of the palm oil mills use open ponds[4]. A further 5-10% use open tanks, while the rest use composting and others (Eco-Ideal 2004; Yeoh 2004a).

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. Also, for biogas capture in anaerobic system, the issue of safety is very much a concern..

Option 5: Composting of empty fruit bunches (EFB) and POME

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 be the need for income from CDM to make the composting attractive.

5) Business culture

Since the current practice of open pond system is able to meet the laws regulating the palm oil industry coupled with the relatively low investment and running costs of this system, management of the palm oil mills are generally reluctant to change to alternative management practice. The proposed project activity falls under the category of alternative practice and related barriers such as technology and financial need to be overcome before management can be convinced to change their business culture.

Option 1: Direct release of POME to nearby water body

Business Culture barrier is not applicable as this option as there is an absolute legal barrier for this option – and that all the other barriers become irrelevant

Option 2: Installation of new treatment system (activated sludge or filter bed type treatment)

The management of the palm oil mills are generally reluctant to change their business culture, especially if it is not a legal requirement, to alternative management practice. Installation of a new treatment system will need to overcome related barriers such as technology and financial before management can be convinced to change their business culture.

Option 3: Continuation of the current situation (business as usual)

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 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.

Option 4: The proposed biogas system not undertaken as a CDM project activity

The palm oil industry generally perceives that the installation of waste treatment systems is principally intended to satisfy statutory effluent discharge requirements.
Biogas produced from the anaerobic digester can be piped and combusted directly to produce heat. In this case, biogas can act as substitute to diesel, where 1.54 m3 of biogas can replace 1 L of diesel. The efficiency of energy conversion is depending on the types of boiler used and is normally high at 80-90%[10]. However, the heat produced from burning of biomass (EFB, Palm kernel, etc) can sustain the heat requirement for palm oil mill. Therefore the extra heat generation from the biogas is not necessary unless there are other processing facilities within the mill or nearby that need biogas for burning and heating[11].

The extent of digesters usage, especially the more advantage closed digester system with biogas recovery is not very common. There are only a few reported (Tennamaram at Batang Berjuntai, Selangor, Keck Sengin Johor, etc.)[12]. The Tennamaram mill for example, had 4 digester tanks and produced average 10,000 m3 of biogas per digester each day[13]. The biogas is used to generate power. For the case of Keck Seng, the biogas is mainly utilized for heat recovery: steam generation. Other new packaged systems utilizing the closed digesters with extended after treatment concepts such as “Zero Ponding” POME treatment system was also introduced by a local private companies, Sustainable Wastewater Engineering Sdn Bhd.[14]

There have been difficulties with the performance of the biogas production and with corrosion in boilers 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.

[10]Pusat Tenaga Malaysia (2000). Feasibility Study on Grid Connected Power Generation Using Biomass Cogeneration Technology.
[11] Study on CDM Potential in Waste Sectors in Malaysia ,*P99*
[12]Yeoh, B.G. (2004). 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*.
[13]Malaysia Energy Centre (PTM). (2000). *Feasibility Study on Grid Connected Power Generation Using Biomass Co-Generation Technology*.
[14]Study on Clean Development Mechanism Potential in the waste Sectors in Malaysia, P49

The concept of capturing biogas to generate power is not well received within the palm oil industry, thus forming a barrier for the introduction of this concept.

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. 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 16 to 22.in cases where there is no need for the extra energy from the biogas for downstream activities. However, one of these steps are viable without extra income from CDM, thus making it unattractive for palm oil mill to adapt this options.

Step 3: Score the barrier

Score for each barrier is done by addressing the questions as set out in the Table B.4.

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
Technological					
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*

Table B.4.: Barrier Test Framework

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, technological 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 03)* to differentiate between options and determine the most likely baseline scenario. In this case, since only one option has been found to be the most plausible, 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 technological 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 technological 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 technological and financial barriers that will prevent it from being implemented with out extra income from CDM.

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. Demonstration of additionality

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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.

The project implementation stages for the biogas utilisation at Sungai Kerang Development are as follows:

- Board decision to implement the biogas CDM project - 18th July 2007[15]
- Quotation for the foundation works for Sungai Kerang - 11th Sept 2007[16]
- Work Order for Foundation Work at site - 12th Sept 2007[17]
- Site validation by DOE - 21st – 23rd Nov 2007

As CDM registration was seriously considered (as shown in the above chronology of events) prior to proceeding with the project activity, as documented in the board meeting, the project activity thus clearly fulfils with the requirements in the additionality tool which reads:

"*Provide evidence that the incentive from the CDM was seriously considered in the decision to proceed with the project activity. This evidence shall be based on (preferably official, legal and/or other corporate) documentation that was available at, or prior to, the start of the project activity".*

The quotation and work order raised is only for the site clearance and foundation work for the biogas project, and not the actual installation of the biogas tanks and other equipment. The technology provider has already started the ground works at time of writing this PDD and commissioning date is expected around late March 2009.

Step 1: Identification of alternatives consistent with laws and regulations

[15]Sungai Kerand Developemnt Sdn. Bhd. Circular Resolution dated 18th July 2007
[16]Quotation No. AQS-NNH/07/Q152 dated 11th Sep 2007 for Foundation Works at Sungai Kerang.
[17] Work Order No. 12176 dated 12thSept 07 for foundation work at site

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 only one option is found to be the most plausible, i.e. the Alternative 4: Continuation of the current situation (business as usual). Therefore, financial analysis for assessing the financial viability of different options is not required for comparison purposes. A financial evaluation of Alternative 4 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 cannot be used and since there is only one alternative in the financial analysis the investment comparison analysis is not relevant. The method that will be applied in this case 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)[18] 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. Ngan & Ngan Holding Sdn. Bhd. uses a 15% IRR benchmark to evaluate their investments[19]. The same benchmark is used for two similar projects, the biogas plant in Cahaya Muda and the compost project in Cahaya Muda. Both projects are under approval as CDM projects.

[18] The IRR referred to is the equity IRR
[19] See Board resolution of 18 July 2007

The benchmark of 15% is relevant for the palm oil sector, but slightly on the low side compared to other players. This supported by a study by Eco-Ideal (2004)[20], 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[21] 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. To be conservative a lower benchmark of 11.9% has been used for evaluation of the investment barrier for the current project.

Sub-step 2c. Calculation and comparison of financial indicators (only applicable to options II and III):
The assumptions for the economic evaluation are presented in table 5. The IRR of the project activity without financing incentives from CDM for all 5, 7, 10 and 20 years are calculated and tabulated below. However, with CDM financing, the IRR can be increased as per Table B.6 for basic assumption of saved electricity and sales of saved biomass at RM70/ton.

Item	Value in Ringgit Malaysia
Biogas system (include Enclosed Flare System)[22]	4,548,000[23]
Civil and electrical	460,000[24]
Packaged Boiler	400,000
CDM consultation, submission & audit fees	128,000
Total Investment costs	**5,536,000**
Annual biogas system operation cost	220,000
Value of CERs (12 Euro x RM4.80)	57.6 RM/ton

Table B.5.: Major assumption for financial analysis

Sub-step 2d. Sensitivity analysis (only applicable to options II and III):

The table below shows a sensitivity analysis for the savings from saved biomass in the calculation of the IRR. The change from Open Flare System to Enclosed Flare System (which started operation on 18/05/2010) would not generate any additional revenue or savings to the project activity. Since the capital costs are based on the actual quotations from the supplier there has not been relevance in having a sensitivity analysis for the investment costs. The sensitivities illustrated are the period of financial projection – from 5,7, 10 and 20 years. This is taking into account the average lifetime of the biogas system at 20 years.

[20] Ecoideal 2004: Study on Clean Development Mechanism Potential in the Waste Sectors in Malaysia. Published on the website: www.ptm.org.my

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

[22] As a conservative approach, cost for the installation of the Enclosed Flare system is not included in the IRR analysis

[23] Quotation No. AQS-NNH/07/Q152 (Rev. 2) dated 21st May 2007.This quotation has been submitted to the validators.

[24] Quotation No. AQS-NNH/07/Q152 (Addendum 2) dated 11th Sept 2007. This quotation has been submitted to the validators.

This sensitivity is shown in Table B.6 base assumptions and for revenue from saved biomass from baseline of RM 70 /ton to a maximum of RM 120/ton[25], as described in detail in attached paper by *Anders Evald et al " Renewable energy resources", page 7 (Table 2.1) and Page 18, Section 2.2.5.2, , Feb 2005*that records Lower Heating Value of PKS at 17.3 GJ/ton and page 18, Current value of PKS stands at 70MR/t

	With out CERs				**With CERs**			
	5 years	**7 years**	**10 year**	**20 year**	**5 years**	**7 years**	**10 year**	**20 year**
Basis assumption[26]	Number not defined (IRR negative for all years)	-30.8%	-19.4%	-5.7%	**78.0%**	**81.4%**	**82.4%**	**82.6%**
Revenue from saved biomass[27]	-15.2%	-4.4%	3.3%	10.2%	**87.8%**	**90.8%**	**91.6%**	**91.8%**

Table B.6.: Sensitivity analysis of the project IRR

The sensitivity analysis clearly shows that the project is only viable if the income from the sale of carbon credits is included. This is not surprising since the value of replacing biomass waste in the existing boiler is very limited, so the main source of income for the project will be the sale of CERs. Even in the best case of the sensitivity analysis the ROE is only 10.2% - below the conservative investment benchmark of 11.9%

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 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:*
  The use of open digester tanks and ponds are clearly in accordance to the palm oil industrial norms of POME treatment. The current POME treatment system is able to meet the discharge requirements by the local authority. In comparison to the project activity, the current system is relatively easy to maintain and there exist no reason to substitute the existing systems(Eco-Ideal 2004; Yeoh 2004a)[28].

[25]Anders Evald et al " Renewable energy resources" *page 7 (Table 2.1) and Page 18, Section 2.2.5.2,*, Feb 2005
[26]*IRR for saved purchase of electricity from grid and saved biomass at RM70/ton (Base Case)*
[27]*IRR for saved purchase of electricity from grid and saved biomass at RM120/ton (Increased value of biomass)*
[28] Ecoideal 2004: Study on Clean Development Mechanism Potential in the Waste Sectors in Malaysia. Published on the website: www.ptm.org.my

The project activity would be among the very few that has been implemented in the palm oil industries in Malaysia. Two similar projects were implemented in the 1980-ies but the operational experience was not convincing and for almost 20 years no other projects followed.

Only with the arrival of the CDM and with the extra income generated from sale of CERs one project has been implemented in 2007 and another one is in registration request stage. Further twenty projects – including the present – are in the process of being approved as CDM projects.

- *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 (Yacob *et al* 2006[29]). 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 technology 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 ponds 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: 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.

[29]S. Yacob , Hassan et al. / Science of the Total Environment 188 366 (2006) 187–196Baseline study of methane emission from anaerobic ponds of palm oil mill effluent treatment

Currently 64 projects are under validation of which 18 projects are based on biogas projects especially from palm oil sector. Table B.7 summarizes proposed CDM projects at validation stage[30]:

Projects	Methodology applied
Methane recovery and utilization project at United Plantations Berhad, Jendarata Palm Oil Mill (Registered)	AM 0013
Methane Recovery for Onsite Utilisation Project at Desa Kim Loong Palm Oil Mill, Sook, Keningau, Sabah.	AM 0022
SIME Bundled Methane Extraction and Combustion Projects	AM 0022
Methane Recovery in Wastewater Treatment, Project AMA07-W-01, Perak	AMS III-H
Tradewinds Methane Extraction and Power Generation Project	AM 0022
KULIM Sindora Biogas Project, Project BCM07_KLM_02	AMS III-H
KULIM Sedenak Biogas Energy Project, Project BCM07_KLM_01	AMS-I.A.+AMS-III.H.
Methane capture from POME for electricity generation in Batu Pahat	AMS-I.D. +AMS-III.H.
KLK Kekayaan Biogas Project, Project BCM07_KLK_13	AMS-III.H.
KKSL Lekir Biogas Project, Project BCM07_SLK_14	AMS-III.H.
Tradewinds Ulu Sebol Biogas Project, Project BCM07_TWD_07	AMS-III.H.
Tradewinds Sungai Kachur Biogas Project, Project BCM07_TWD_06	AMS-III.H.
Tradewinds Serasa Biogas Project, Project BCM07_TWD_05	AMS-III.H.
Methane Recovery in Wastewater Treatment, Project AMA07-W-05, Pahang (Flaring)	AMS-I.D.+AMS-III.G.
Methane Recovery in Wastewater Treatment, Project AMA07-W-07, Kedah (Flaring)	AM22
Biogas Generation at Kluang Oil Palm Processing Mill	AM22
Tradewinds Permai Biogas Project, Project BCM07_TWD_04	AMS-III.H.
Tradewinds Batu Putih Biogas Project, Project BCM07_TWD_03	AMS-III.H.

Table B.7.:Summary of biogas projects under validation

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 eleven projects under development including the present project. Of these fifteen 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[31].

[30] As of 31st January 2008

[31] Hassan Ibrahim, 2004: Preliminary Assessment Of Selected Renewable Energy And Energy Efficiency Technologies p 85

For the 1-2 projects already implemented in the 1980-ties the capital costs are sunk costs and as long as the operational costs are lower than the operational benefits – as is also the case in the suggested project – it makes financial sense to keep on running the biogas plant, but new plant is not build as the capital costs can not be recovered.

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.

As described in Step 2, the approval and registration of the project activity will alleviate the economic barrier of the project activity thus enable the project to be undertaken by providing a necessary 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[32]). The successful implementation of the project will also project an improved image on palm oil, as this should eliminate methane emission from palm oil mills as an issue for the EU objection of the CPO production process. In addition, the project activity also shall reduce the usage of fossil fuel in mills/palm oil processing.

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
>>
<u>Project Emissions:</u>

Total project emissions (E_{PA}) are calculated using Equation 1 in AM0022 as follows:

Equation from AM0022:

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

The above equation is modified to include $PE_{EC,y}$ and $PE_{sludge\_dispose,y}$ and represented as below:

$$E_{PA} = E_{CH4\_lagoons\_PA} + E_{CH4\_NAWTF} + E_{CH4\_IC+leaks} + PE_{EC,y} + PE_{sludge\_dispose,y}$$

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
$PE_{EC,y}$	=	emissions due to grid electricity consumption by the project activity

[32]MOSTE – Ministry Of Science, Technology and Environment

$PE_{sludge\_dispose,y}$ = Project emissions due to sludge disposal at disposal site. Estimation is based on formulae stated in ACM0014 as there is no provision in AM0022 for these emissions estimation.

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

The raw POME will be treated in the closed tank anaerobic digester system with a sludge separation sub-system built-in for the removal of sludge before the treated effluent is discharged to the aerobic ponds. Total COD removal after the anaerobic tanks and sludge removal is expected to be around 95%. With such removal rate, the existing anaerobic lagoons will be closed after the implementation of the project activity. The treated POME will, therefore, be channelled into the subsequent aerobic and maturation ponds for further treatment before the final discharge to the waterways.

The project and baseline boundary does not include the aerobic ponds downstream of the anaerobic treatment. The loading of the aerobic ponds outside the project boundary will be similar or lower than in the baseline case. There will thus not be any be no further fugitive methane emissions from the ponds after the anaerobic digester tanks.

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

As described in detail in section A.4.3 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 digesters.
Steel tanks and steel piping system in the construction of the biogas plant, which are widely known to withstand very low to very high pressure gas storage and transfer.
The fabrication and installation of the digester tanks will follow the relevant Technical & Engineering Specification and Standards. With proper engineering welding, the tank is guaranteed to provide 100% seal over the operational life of the project
A report of the hydraulic testing and gas leakage testing of the bio-digester tanks proving negligible leakage of the tanks during commissioning will be provided to the project owner.

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

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 , biomass boilerand inthe Enclosed flare.

These processes are the sources for methane emissions during inefficient combustion. Methane emissions from the combustion in the boiler and the Enclosed flare will be included into project emissions calculation using Equation 7 in AM0022 as follows:

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

where:

E_{CH4_IC} = The sum is made over routes *r* for methane destruction – combustion in biomass boiler and Enclosed flare;

V_r = biogas combustion process volume in route *r* (Nm^3) i.e. biomass boiler

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

f_r = proportion of biogas destroyed by combustion in the biomass boiler

CH_4 emissions due to incomplete combustion during heat generation is not considered as biogas is destructed for gainful use that is fed to biomass boiler for heat generation and efficiency of 100% is shall be applied. However, as conservative estimation, during project implementation CH_4 emissions due to incomplete combustion during heat generation would be calculated by assuming combustion of biogas in biomass boiler at 99.66% efficiency as based on monitoring value during 2nd monitoring period.

PE_{flare} = are the project emissions from flaring of residual gas stream (tCO_2e) 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.

The use of 99.66% is deemed conservative. The biogas will be combusted in the existing biomass boiler. The expected emission of biogas from stationary combustion is very low according to IPCC[33] (2006). IPCC gives a default value of methane emissions from stationary combustion is given as 1 kg CH_4/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 $kgCO_2e$ per TJ of biogas burned.

The total amount of methane is expected to be 4,751,394 m^3 corresponding to 175 TJ (Using NCV Methane of 50.4 $TJ/GgCH_4$, and Methane density of 0.716 $kgCH_4/Nm^3CH_4$)). The total emission of methane from the power production is expected to be 242.9 tons CO_2e/year as compared to 4.93 tons CO_2e/year (calculated based on emissions of 28.77 kg CO_2e/TJ using the IPCC default values).

The installation will include an Enclosed flare to be used in emergencies, when the biomass boiler will not be able to use the biogas. In such emergency cases the $PE_{flare,\ y}$ will calculated based on the methodological "Tool to determine project emissions from flaring gases containing methane".

The PE_{flare} will be calculated based on the assumption that the flare efficiency is the default value of 90% prescribed by the "Tool" (from 18/05/2010 onwards). Since the planned flow of gas to the flare is zero the ex-ante assumption of project emissions from the flare will be zero. The amount of gas to the flare will be monitored as well as the functioning flare – if in use to verify the assumptions.

The project consists of installation of four POME digester tanks and retrofitting existing boilers. Under scheduled maintenance, each of the equipment mentioned will be shutdown one at a time. The remaining equipment will be running as usual Therefore it is unlikely all the equipment will be shut down simultaneously and any need for the methane gas to be flared.

[33] 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

The table below shows that at any one tome, either boiler is able to combust all the biogas produced by the bio digester system as the required energy for steam production is far greater than the maximum energy content of the biogas.

Description	Energy Required in current Boilers	
	Boiler #2	**Boiler #1**
Steam capacity (ton / hour)	45	30.00
Full load hours (hours / year)	6,570	6,570.00
Annual steam production (ton / year)	295,650	197,100.00
Steam energy (GJ / t on steam)	2.88	2.88
Energy per annum (GJ / year)	851,472	567,648.00
Boiler efficiency (%)	0.80	0.80
Energy needed (GJ / year)	1,064,340	709,560.00
Maximum Amount of biogas produced in anaerobic digester (Nm^3/yr)	7,602,229.94	7,602,229.94
Biogas Energy content (GJ/Nm3 biogas)	0.023	0.023
Maximum energy produced by the biogas (GJ/yr)	174,851	174,851
Additional energy needed by boilers if maximum amount of biogas is used. (GJ/yr)	**889,489**	**534,709**

Table B.8. Total energy required by each boiler to generate steam.

Project emissions due to grid electricity consumption by the project activity ($PE_{EC,y}$):

The electricity used for the project activity would be from renewable source i.e. electricity generated from the biomass-biogas boiler/turbine generating system.

However, since there may be time when electricity may need to be imported from grid i.e. when the boiler/turbine system is not running, the project emissions due to grid electricity consumption by the project activity ($PE_{EC,y}$) would be calculated by applying the following formula, in accordance with the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" version 1 (EB39):

$$PE_{EC,y} = \sum EC_{PJ,j,y} \text{ x } FE_{EL,j,y} \text{ x } (1 + TDL_{j,y})$$

Where:

$\sum EC_{PJ,j,y}$ = Total electricity consumed by the project activity (MWh)

$FE_{EL,j,y}$ = Grid emission factor (t CO_2/MWh)

$TDL_{j,y}$ = Transmission and distribution losses

Project emissions due disposal of sludge ($PE_{sludge\_dispose,y}$):

These emissions can be estimated from the following equation, taken from methodology ACM0014 (version 05.0.0) equations 16, 17 & 18 as follows:

$$PE_{sludge\_dispose,y} = COD_{sludge,y} \text{ x } B_o \text{ x } MCF_{sludge} \text{ x } GWP_{CH4} + N_{sludge,y} \text{ x } EF_{N2O,sludge} \text{ x } GWP_{N2O}$$ – Ref Eq (16) of AM0014

with

$COD_{sludge,y} = \sum_{m=1}^{12} S_m \times w_{sludge,COD,m}$ Ref Eq (17) of ACM0014

and

$N_{sludge,y} = \sum_{m=1}^{12} S_m \times w_{N,sludge,m}$ Ref Eq (18) of ACM0014

where

$PE_{sludge,dispose\ ,y}$	=	Project emissions from disposal of sludge in year y (tCO_2e/yr)
$COD_{sludge,\ y}$	=	Chemical Oxygen Demand of the sludge disposed (tCOD/yr)
B_o	=	maximum methane producing capacity (0.25 $tCH_4/tCOD$)
MCF_{sludge}	=	methane conversion factor (fraction) assumed to be equal to 0.05
GWP_{CH4}	=	Global Warming Potential of methane valid for the applicable commitment period (21 tCO_2e/tCH_4)
$W_{sludge,COD,LA,m}$	=	Average chemical oxygen demand in the sludge disposed after the dewatering process in month m (t COD/t sludge)
S_m	=	Amount of sludge disposed in month m (t sludge/month)
$N_{sludge,y}$	=	Amount of nitrogen in the sludge disposed in year y (t N/yr)
$W_{N,sludge,m}$	=	Mass fraction of nitrogen in the sludge disposed in month m (t N/t sludge)
$EF_{N2O,sludge}$	=	N_2O emission factor for nitrogen from sludge disposed (0.016 t N_2O/t N)
GWP_{N2O}	=	Global Warming Potential of nitrous dioxide (310 tCO_2e/tN_2O)

Baseline Emissions:

The total baseline emissions (E_{BL}) comprise of the fugitive methane emissions from the existing anaerobic lagoons ($E_{CH4\_anaerobic\_BL}$) and off site power generation ($E_{CO2\_power\_BL}$). Calculations are conducted using Equation 8 in AM0022:

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

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 formula in Equation 2 in AM0022:

$$E_{CH4\_anaerobic\_BL} = M_{BL\_lagoon} * EF_{CH4} * GWP_{CH4}$$

where:

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

Amount of organic material removed by anaerobic processes in the lagoons(M_{BL_lagoon}) is calculated with Equation 3 in AM0022:

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

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 leads to degradation into hydrogen sulphide (H_2S) found in traces in the biogas. This loss is estimated to 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 5% of total organic material removed in the lagoon. The estimate of 5% has been substantiated by calculations based on actual data from the mill and using formulas contained in ACM0014 and through laboratory tests of POME from the mill[34].

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

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

where,

$M_{BL\_lagoon\_input}$ = input of organic material 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 lagoons, which both measurements are shown in the above tables. The following formula will be applied for the calculation:

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

The value used for $COD_{BL\_lagoon\_inlet}$ and $COD_{BL\_lagoon\_outlet}$ are 75, kg/m^3 and 3 kg/m^3, respectively. Therefore, R_{BL_ponds} equals to 0.96. To be conservative, 95% will be used in baseline calculation.

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

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

$$= Q_{POME\_inlet} * COD_{BL\_ponds\_inlet}$$

Where

Q_{POME_inlet} = Volume of Palm Oil Mill Effluent (POME) entering the anaerobic lagoons.(m^3).

$COD_{BL\_ponds\_inlet}$ = COD of POME entering the anaerobic lagoons. (kg/m^3)

CO_2 emissions from fossil fuel use for off site power generation ($E_{CO2\_power\_BL}$):

The biomass boiler and steam turbine can produce most of the power for the use of the palm oil mill.

[34] Report from BIOCHEM Laboratories on 25/07/2008

The baseline emissions from replacement of power from the grid are calculated using Equation 10 from AM0022_v4:

$E_{CO2\_power\_BL}$ = EL * CEF

where:

EL = 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 = Carbon emission factor for the electricity displaced by the electricity generated from the biogas.

The biogas generated will be burned in the existing boiler to produce the same amount of electricity by the steam turbine. It will however replace the use of some of the biomass that can be sold as revenue to the project.

Therefore, there will not be extra electricity generated by the biogas to displace current usage by the office.

EL will then be = “0”

Therefore, the CO_2 emissions from displaced electricity will be **0 tCO_2/year.**

<u>Leakage Emissions:</u>

The project is not expected to have any off site effects on emissions and there will thus be no leakage effects.
The emissions from the transport of sludge to the compost site is included as project emissions in the PDD for the compost project and are not included here to avoid double counting.

<u>Emission Reductions:</u>

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

In order to ensure the above equation delivers a conservative estimate of emission reductions, it will be verified during the project implementation that the emissions of CH_4 in the baseline situation are not higher than the total emissions of biogas from the digester tanks and lagoon 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/or 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 fixed ex ante

(Copy this table for each piece of data and parameter.)

<table>
<tr><td>Data / Parameter</td><td>COD $_{BL\_ponds\_inlet}$</td></tr>
<tr><td>Unit</td><td>kg/m^3</td></tr>
<tr><td>Description</td><td>COD of POME entering the existing open anaerobic ponds</td></tr>
<tr><td>Source of data</td><td>Sampled</td></tr>
<tr><td>Value(s) applied</td><td>
<table>
<tr><th>Date</th><th>COD, mg/l</th></tr>
<tr><td>17/9/07</td><td>93,423</td></tr>
<tr><td>18/9/07</td><td>89,396</td></tr>
<tr><td>19/9/07</td><td>92,617</td></tr>
<tr><td>20/9/07</td><td>98,255</td></tr>
<tr><td>21/9/07</td><td>99,866</td></tr>
<tr><td>Average</td><td>94,711</td></tr>
</table>
Even though the measured values are higher a value of 75,000 mg COD/litre has been used in the calculations to be conservative</td></tr>
<tr><td>Choice of data or Measurement methods and procedures</td><td>Measurements were performed by Spectrum Laboratories (Penang) Sdn. Bhd. an accredited laboratory to the National Laboratory Accreditation Scheme (SAMM). POME sampled on and analysed using the Department of Environment (Malaysia) Revised Standard Methods (1985) for Analysis of Rubber and Palm Oil Mill Effluent.</td></tr>
<tr><td>Purpose of data</td><td>Ex-ante baseline emissions</td></tr>
<tr><td>Additional comment</td><td>-</td></tr>
</table>

<table>
<tr><td>Data / Parameter</td><td>COD $_{BL\_ponds\_outlet}$</td></tr>
<tr><td>Unit</td><td>kg/m^3</td></tr>
<tr><td>Description</td><td>COD of POME leaving the existing open anaerobic ponds</td></tr>
<tr><td>Source of data</td><td>Measurement</td></tr>
<tr><td>Value(s) applied</td><td>A conservative value of 3,000kg/m^3 COD has been used
<table>
<tr><th>Date</th><th>COD, mg/l</th></tr>
<tr><td>25/03/08</td><td>5,180</td></tr>
<tr><td>8/4/08</td><td>1,013</td></tr>
<tr><td>16/4/08</td><td>2,000</td></tr>
</table>
The average value of these three samples is 2,737 mg/l. A value of 3,000 mg COD/litre has been used in the calculations to be conservative.</td></tr>
<tr><td>Choice of data or Measurement methods and procedures</td><td>Anaerobic Digestion System’s COD removal efficiency was calculated based on COD of POME entering the existing open anaerobic ponds value and pond retention capacity & dimension. Based on the calculation, the overall ponds COD removal efficiency expected to be approximately 96%.</td></tr>
<tr><td>Purpose of data</td><td>Ex-ante baseline emissions</td></tr>
<tr><td>Additional comment</td><td>COD of POME entering the existing open anaerobic ponds</td></tr>
</table>

Data / Parameter	**EF_{CH4_boiler} - Methane emission from burning of biogas in boiler**
Unit	kg/TJ
Description	Remaining emission of methane from combustion of biogas in the existing biomass boiler
Source of data	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value(s) applied	1.37 kg methane/TJ (calculated as the original 1 kg methane/TJ * conservativeness factor of 1.37)
Choice of data or Measurement methods and procedures	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.
Purpose of data	For calculation of f_r (heating system combustion efficiency)
Additional 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	ρ_{CH4}
Unit	kg/m^3
Description	Density of methane gas at normal conditions
Source of data	Tool to determine project emissions from flaring gases containing methane
Value(s) applied	0.716
Choice of data or Measurement methods and procedures	Parameter defined within the tool, “Tool to determine project emissions from flaring gases containing methane”.
Purpose of data	Project emission calculations
Additional comment	

Data / Parameter	$C_{chemical\_ox}$
Unit	$kgSO_4/m^3$
Description	Amount of oxidising agent – here only SO_4 – in the POME entering the anaerobic digester tanks.
Source of data	Sampled
Value(s) applied	Assumed 1% of total organic materials removed in the digester tanks.
Choice of data or Measurement methods and procedures	
Purpose of data	Ex-ante baseline emissions
Additional comment	

Data / Parameter	$R_{deposition}$
Unit	Kg COD/m^3
Description	Amount of organic material lost through deposition in the anaerobic lagoons.
Source of data	Sampled
Value(s) applied	Assumed 5% of total organic materials removed in the anaerobic lagoons.
Choice of data or Measurement methods and procedures	The value for $R_{Deposition}$ is justified through two approaches: a) A calculation based on project specific data b) Laboratory test on POME from the project site <u>The calculation approach</u> is based on the approved methodology ACM 14 ver 1 since this at present the latest approved methodology for biogas plants at point of calculation. The methodology allows calculating the formation of methane in the baseline from COD retained/sedimented in the anaerobic lagoons by estimated the methane formed from carry over. Here the calculation is used to calculate the amount of COD left in the ponds after formation of methane. Since the methodology is conservative in estimating the amount of methane formed i.e. then the methodology should allow a maximum of COD to be left in the sediment. The calculation has been updated to use ponds of 5 meters and the actual COD measurements from the in-let and out-let of the anaerobic ponds in mill. Spreadsheet calculation to justify the $R_{deposition}$. Using ACM0014 gives a value of $R_{deposition}$ of 2.76%. <u>The laboratory test</u> is based on samples of POME from the palm oil. The reference for measurement of the fraction of COD lost through deposition (R deposition) is the Settleable Solids Test called the "Standard Methods for the Examination of Water and Wastewater, 2540 F " . This methodology is used to prepare and analyze the sample for the calculation of COD lost through deposition. The methodology is applicable to the issue at hand since the COD lost through deposition will be linked to the deposition of solids in the sample. The average results of five samples is 1.19% COD lost through sedimentation[35]. Based on these two approaches it is justified to use 5% as a conservative value for $R_{deposition}$ as both approaches to estimate the rate is lower than the value used in the calculations.
Purpose of data	Baseline emission calculations
Additional comment	

[35] Report from BIOCHEM Laboratories on 25/07/2008

Data / Parameter	**R_{lagoon}**
Unit	%
Description	Total organic removal ratio of the anaerobic lagoons.
Source of data	Sampled
Value(s) applied	Assumed 95% efficiency of total organic removal ratio based on COD data entering and exiting anaerobic lagoons.
Choice of data or Measurement methods and procedures	The average value for COD into the anaerobic lagoons is 94,711 ppm COD and the average value for COD leaving the lagoons is 1,516 ppm COD indicating a reduction efficiency of 98%. A value of 95% has been chosen to be conservative.
Purpose of data	Baseline emission calculations
Additional comment	

Data / Parameter	**CEF**
Unit	kg CO_2/kWh
Description	Carbon Emission Factor for the electricity displaced by the electricity generated from the biogas.
Source of data	Carbon emission factor for renewable source
Value(s) applied	0
Choice of data or Measurement methods and procedures	The CEF used is the lower value of the two power sources used in the plant. One source is direct import from the grid with CER value of 0.614. The other source is power generated by the biomass boiler with a CEF value of 0, as the emission is considered as carbon neutral. Therefore, the CEF value used here is 0.
Purpose of data	Baseline emission calculations
Additional comment	

Data / Parameter	**$EF_{El, j,y}$**
Unit	t CO_2e/MWh
Description	Grid emission factor for the Peninsular Malaysia Grid
Source of data	GreenTech Malaysia
Value(s) applied	0.683
Choice of data or Measurement methods and procedures	Study on Grid Connected Electricity Baselines in Malaysia, by CDM Energy Secretariat, GreenTech Malaysia, year 2009.
Purpose of data	Project emission calculations
Additional comment	For project emissions $PE_{EC,y}$ calculation.

Data / Parameter	TDL $_{j,y}$
Unit	%
Description	Transmission and distribution losses
Source of data	Tenaga Nasional Berhad (TNB) Report, 2010
Value(s) applied	10
Choice of data or Measurement methods and procedures	TNB is the sole grid electricity distributor in Peninsular Malaysia.
Purpose of data	Project emission calculations
Additional comment	-

Data / Parameter	B_o
Unit	t CH_4/t COD
Description	Maximum methane producing capacity, expressing the maximum amount of CH_4 that can be produced from a given quantity of chemical oxygen demand (COD)
Source of data	ACM0014, version 05.0.0
Value(s) applied	0.25 for conservative estimation
Choice of data or Measurement methods and procedures	-
Purpose of data	Project emission calculations
Additional comment	-

Data / Parameter	MCF_{sludge}
Unit	-
Description	Methane conversion factor for the disposal of sludge
Source of data	ACM0014, version 05.0.0
Value(s) applied	0.05
Choice of data or Measurement methods and procedures	-
Purpose of data	Project emission calculations
Additional comment	-

Data / Parameter	**$EF_{N2O,sludge}$**
Unit	t N_2O/t N
Description	N_2O emission factor for nitrogen from sludge dispose
Source of data	ACM0014, version 05.0.0
Value(s) applied	0.016
Choice of data or Measurement methods and procedures	-
Purpose of data	Project emission calculations
Additional comment	-

Data / Parameter	**GWP_{N2O}**
Unit	t CO_2/t N_2O
Description	Global Warming Potential for N_2O
Source of data	Climate Change 1995, The Science of Climate Change: Summary for Policymakers and Technical Summary of the Working Group I Report, page 22. as obtained via link http://unfccc.int/ghg_data/items/3825.phphttp://unfccc.int/ghg_data/items/3825.php
Value(s) applied	310 for conservative estimation
Choice of data or Measurement methods and procedures	-
Purpose of data	Project emission calculations
Additional comment	-

Data / Parameter	f_r
Unit	%
Description	Heating system combustion efficiency
Source of data	2006 IPCC Guidelines, Volume 2, Chapter 2, Table 2.2, p.2.17 for Stationary Combustion sources burning on biogas fuel
Value(s) applied	99.66
Choice of data or Measurement methods and procedures	The applied value is the actual monitoring data for monitoring period #2 (01/2010 to 09/2010) which is actually the methane emissions from biogas and biomass combustion in the boiler. However, use of this value is deemed conservative as compared to the default value calculated by using IPCC values as follow: The value of f_r is calculated using IPCC default values: NCV_{CH4} = 50.4 TJ /Gg CH_4 EF_{CH4_SC} = 1.37 kg CH_4/TJ Therefore, (1 - f_r) = NCV_{CH4} x EF_{CH4_SC} =0.000069 =0.0069 % f_r = 99.931% The biogas is burned together with the solid biomass, therefore, it is not possible to measure the combustion efficiency of the biogas in the heating system. Instead, IPCC default value for methane emissions for industrial boilers used to estimate the project emissions. The default value for methane emissions is 1 kg methane per TJ of net calorific value of the fuel gas consumed.
Purpose of data	Project emission calculations
Additional comment	The existing biomass boiler will continue to combust solid biomass fuels 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 a default value for combustion of biogas for the calculation of methane emissions due to incomplete combustion in the biomass boiler. Additionally, based on ACM0014 version 1.0 & AMS-III.H version 14, combustion of CH_4 shall be deemed 100% efficiency if biogas is destructed for gainful purposes.

B.6.3. Ex ante calculation of emission reductions

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<u>Project Emissions:</u>

Fugitive methane emissions from the subsequent anaerobic lagoon after new closed tank digesters ($E_{CH4\_lagoon\_PA}$):
The existing anaerobic lagoons 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 B.3).

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. Therefore the combustion is expected to be very efficient. The IPCC default emission factor of 1.37[36] kg methane/TJ is used as a starting point to calculate the emission from the boiler.

For the Enclosed flare a combustion efficiency of 90% is used based on the default value in the "Tool to determine project emissions from flaring gases containing methane" for Enclosed flares (from 18/05/2010 onwards). The flow to the Enclosed flare is expected to be zero under normal operations. This will be monitored during operation of the flare.

Project emissions due to grid electricity consumption by the project activity ($PE_{EC,y}$):
Considering the full load hours of the boiler is 6,570 hours, there are 2,190 hours in a year that the boilers are not running, hence grid electricity would be imported and used for the project activity.

Hence, for *ex-ante*, the project emissions $PE_{EC,y}$ would be calculated as follow:

$PE_{EC,y}$ = [Power consumption due to project activity (kW)] x 2,190 hrs x 0.683 (tCO_2/MWh) x 0.1
= 61 (kW) x 2,190 (h) x 0.683 (tCO_2/MWh) x 1.1
= 100.4 tCO_2/year

Project emissions due disposal of sludge ($PE_{sludge\_dispose,y}$):

For ex-ante, the project emissions $PE_{sludge\_dispose,y}$ is estimated as follow:

$PE_{sludge\_dispose,y}$ (tCO_2e) = [(1,458 t sludge/yr x 0.1491 tCOD/t sludge) x 0.25 tCOD/tCH_4 x 0.05 x 21] + [(1,459 t sludge/yr x 0.002 t N/t sludge x 0.016 t N2O/kgN x 310]
= 57.1 + 14.5
= 71.6

where:
S_m = 270,000 m^3 POME/yr x 1.96 kg/m^3
= 529,200 kg/yr (dry weight basis)
= 1,459 t sludge dispose/yr (sludge moisture content of 63.72%)
$W_{sludge,COD,m}$ = 0.1491 t COD/t sludge
(Assumption: Concentration of suspended solids in treated POME = 1.96 kg/m^3)

[36] Including an uncertainty factor of 1.37

$W_{N,sludge,m}$ = 0.002 t N/t sludge (0.2% N in sludge based on laboratory test results)
= 0.0055 t N/t sludge (dry weight basis; with sludge moisture content of 63.72%)

No leakage is assumed to occur in the present calculation.

Year	$E_{CH4\_lagoons\_PA}$ (tCO_2e)	E_{CH4_NAWTF} (tCO_2e)	$E_{CH4\_IC+leaks}$ (tCO_2e)	$PE_{EC,y}$ (tCO_2)	$PE_{sludge\_dispose,y}$ (tCO_2e)	E_{PA} (tCO_2e)
Year 1*	0	0	4.9	**100.4**	**71.6**	**105.3**
Year 2	0	0	242.9	**100.4**	**71.6**	**414.9**
Year 3	0	0	242.9	**100.4**	**71.6**	**414.9**
Year 4	0	0	242.9	**100.4**	**71.6**	**414.9**
Year 5	0	0	242.9	**100.4**	**71.6**	**414.9**
Year 6	0	0	242.9	**100.4**	**71.6**	**414.9**
Year 7	0	0	242.9	**100.4**	**71.6**	**414.9**
Year 8	0	0	242.9	**100.4**	**71.6**	**414.9**
Year 9	0	0	242.9	**100.4**	**71.6**	**414.9**
Year 10	0	0	242.9	**100.4**	**71.6**	**414.9**

*Year 1 starts from 1st April 2009 until 31st March 2010

Table B.9.: Summary of Project Emissions (E_{PA})

Baseline Emissions:

Year	$E_{CH4\_anaerobic\_BL}$ (tCO_2e)	$E_{CO2\_power\_BL}$ (tCO_2e)	**E_{BL} ($t\ CO_2e$)**
Year 1*	78,967	0	78,967
Year 2	78,967	0	78,967
Year 3	78,967	0	78,967
Year 4	78,967	0	78,967
Year 5	78,967	0	78,967
Year 6	78,967	0	78,967
Year 7	78,967	0	78,967
Year 8	78,967	0	78,967
Year 9	78,967	0	78,967
Year 10	78,967	0	78,967

*Year 1 starts from 1st April 2009 until 31st March 2010

Table B.10.: Summary of Baseline Emissions (E_{PA})

Leakage Emissions:

Leakage is considered to be negligible.

B.6.4. Summary of ex ante estimates of emission reductions

Year	**Baseline emissions (t CO_2e)**	**Project emissions (t CO_2e)**	**Leakage (t CO_2e)**	**Emission reductions (t CO_2e)**
Year 1*	78,967	105.3	0	**78,861**
Year 2	78,967	414.9	0	**78,552**
Year 3	78,967	414.9	0	**78,552**
Year 4	78,967	414.9	0	**78,552**
Year 5	78,967	414.9	0	**78,552**
Year 6	78,967	414.9	0	**78,552**
Year 7	78,967	414.9	0	**78,552**
Year 8	78,967	414.9	0	**78,552**
Year 9	78,967	414.9	0	**78,552**
Year 10	78,967	414.9	0	**78,552**
Total	**789,665**	3,839.1	**0**	**785,826**
Total number of crediting years	10			
Annual average over the crediting period	**78,967**	**383.9**	**0**	**78,583**

*Year 1 starts from 1st April 2009 until 31st March 2010

B.7. Monitoring plan
B.7.1. Data and parameters to be monitored
(Copy this table for each piece of data and parameter.)

Data / Parameter	ID1: Q_{POME_inlet}
Unit	m^3
Description	Volume of POME entering the anaerobic digester tanks
Source of data	Measured
Value(s) applied	0.6 For present estimation purposes, the amount of POME generated is estimated based on the FFB processed (projection) in the Mill, i.e. 0.6 m^3 POME/tFFB. The present annual FFB production level is 450,000 tonnes. That will lead to total annual POME volume of 270,000 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.
Measurement methods and procedures	Flowmeter will be installed at the inlet to the digester tanks for measurement of the influent wastewater into the tanks. Continuous recording and monitoring is 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.
Monitoring frequency	
QA/QC procedures	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.
Purpose of data	
Additional comment	Level of uncertainty for data is expected to be low. Data shall be archived during the crediting period and at least 2 years after the crediting period.

Data / Parameter	ID2: Q_{POME_outlet}
Unit	m^3
Description	Volume of POME leaving the anaerobic digester tanks
Source of data	Measured
Value(s) applied	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.
Measurement methods and procedures	Flowmeter will be installed at the outlet to the digester tanks for measurement of the influent wastewater into the tanks. Continuous recording and monitoring is 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.
Monitoring frequency	
QA/QC procedures	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.
Purpose of data	
Additional comment	Data shall be archived during the crediting period and at least 2 years after the crediting period. Level of uncertainty for data is expected to be low.

Data / Parameter	ID3: $COD_{PA\_tanks\_inlet}$
Unit	$kgCOD/m^3$
Description	COD of POME entering the closed anaerobic digester tanks
Source of data	Sampled
Value(s) applied	75,000 mgCOD/l -conservative estimate based on samples at the mill Date / COD, mg/l: 17/9/07 – 93,423 18/9/07 – 89,396 19/9/07 – 92,617 20/9/07 – 98,255 21/9/07 – 99,866 Average – 94,711 Even though the measured values are higher a value of 75,000 mg COD/litre has been used in the calculations to be conservative
Measurement methods and procedures	Daily samples will be made and analysed at the palm oil mills laboratory according to the specifications 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
Monitoring frequency	
QA/QC procedures	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.
Purpose of data	
Additional comment	Level of uncertainty for data is expected to be low / medium .Data shall be archived during the crediting period and at least 2 years after the crediting period.

Date	COD, mg/l
17/9/07	93,423
18/9/07	89,396
19/9/07	92,617
20/9/07	98,255
21/9/07	99,866
Average	94,711

Data / Parameter	ID4: $COD_{PA\_treatment\_outlet}$
Unit	kgCOD/m^3
Description	COD of POME leaving the new anaerobic digester system
Source of data	Sampled
Value(s) applied	3,000 mgCOD/l – based on the specifications of the technology supplier
Measurement methods and procedures	Daily samples will be made and analysed at the palm oil mills laboratory according to the specifications 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
Monitoring frequency	
QA/QC procedures	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.
Purpose of data	
Additional comment	Level of uncertainty for data is expected to be low / medium. . Data shall be archived during the crediting period and at least 2 years after the crediting period.

Data / Parameter	ID5: V_{boiler}
Unit	Nm^3
Description	Volume of biogas sent to facility heater, in this case, the boiler.
Source of data	Measured
Value(s) applied	7,602,230m^3 / year Temperature and pressure of the gas will be measured continuously with the volume to allow for normalisation. The volume of biogas is calculated from the amount of methane produced according to AM00022 and with the use of the density of methane 0.716 kg/Nm^3 (at 25^{o}C) and the share of methane in the biogas (62.5% - ID No. 11)
Measurement methods and procedures	The flow meter will be installed at 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. During calibration of the meter a replacement meter will be installed for continuous measuring. The replacement meter used will have a valid calibration certificate and of the name nature of the meter removed.
Monitoring frequency	
QA/QC procedures	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.
Purpose of data	
Additional comment	Data shall be archived during the crediting period and at least 2 years after the crediting period.

Data / Parameter	ID7: EL
Unit	MWh
Description	Electricity produced by the biomass/biogas boiler/turbine system and used on site
Source of data	Measurement of the power produced
Value(s) applied	5,784 MWh – average of the power supplied by the existing turbine to the mill.
Measurement methods and procedures	The power output from the biomass/biogas boiler/turbine system will be registered continuously through power meters
Monitoring frequency	
QA/QC procedures	The power meters are accurate to 0.1 amp and will be calibrated annually as per the specification guide.
Purpose of data	
Additional comment	Level of accuracy for recording power production is high The biogas is combusted in the steam boiler along with other biomass fuels such as Palm Kernel Shells and Fibre to produce steam. The amount of power produced will not increase as there is no increase in boiler capacityhence no grid electricity is displaced.

Data / Parameter	ID9: $V_{flaring}$ (in AM0022) and $FV_{RG, h}$(in Tool for flaring)
Unit	Nm^3
Description	Biogas sent to flaring
Source of data	Measured
Value(s) applied	0 (zero) No flaring is expected under normal operations.
Measurement methods and procedures	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 flowmeter when flaring takes place and the results will be recorded by the plant technician. During calibration of the meter a replacement meter will be installed for continuous measuring. . The replacement meter used will have a valid calibration certificate and of the name nature of the meter removed.
Monitoring frequency	
QA/QC procedures	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.
Purpose of data	
Additional comment	The flare will be Enclosed flare. Level of uncertainty for data is expected to be low. Data shall be archived during the crediting period and at least 2 years after the crediting period.

Data / Parameter	ID11: C_{CH4}(in AM00022) and fv $_{CH4, h}$ (in Tool for flaring)
Unit	%
Description	Methane concentration in biogas
Source of data	Measured
Value(s) applied	62.5% - based on information from the technology supplier
Measurement methods and procedures	A methane detector and logger will be installed along with the flowmeter 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, a replacement meter of same nature and with valid calibration certificate will be installed in place.
Monitoring frequency	
QA/QC procedures	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.
Purpose of data	
Additional comment	Data shall be archived during the crediting period and at least 2 years after the crediting period.

Data / Parameter	ID12: $PE_{flare,\ y}$
Unit	tCO_2e/year
Description	Project emissions of methane from incomplete combustion in the flare
Source of data	Measurement and calculation by project participants
Value(s) applied	0 (zero) t CO_2e/year No gas is expected to go to the flare under normal operations
Measurement methods and procedures	N/A
Monitoring frequency	
QA/QC procedures	According to “tool to determine project emissions from flaring gases containing methane”, QA/QC procedure will be applied for the parameters used for determining the project emissions from flaring of the residual gas stream in the year, *y* The PE_{flare} will be calculated based on the assumption that the flare efficiency is the default value of 90% prescribed by the “Tool” (from 18/05/2010 onwards). Since the planned flow of gas to the flare is zero the ex-ante assumption of project emissions from the flare will be zero. The amount of gas to the flare will be monitored as well as the functioning flare – if in use to verify the assumptions. The equipment to be installed for the flaring system includes: • A gas flow meter that records the amount of biogas sent to flare. • An Enclosed flare system comprising a standard flare burner equipped with a Type N thermocouple for the measurement of temperature in the exhaust gas of the flare in accordance with the “Tool”. The flare efficiency in the hour h ($\eta_{flare,h}$) is determined as follows: – 0% if the temperature in the exhaust gas of the flare (T_{flare}) is below 500 °C for more than 20 minutes during the hour h; – 50%, if the temperature in the exhaust gas of the flare (T_{flare}) is above 500 °C for more than 40 minutes during the hour h, but the manufacturer’s specifications on proper operation of the flare are not met at any point in time during the hour h; – 90%, if the temperature in the exhaust gas of the flare (T_{flare}) is above 500 °C for more than 40 minutes during the hour h and the manufacturer’s specifications on proper operation of the flare are met continuously during the hour h. A recording system that records the temperature in the exhaust gas of the flare.
Purpose of data	
Additional comment	Data shall be archived during the crediting period and at least 2 years after the crediting period.

Data / Parameter	ID13: C $_{chemical\_ox}$
Unit	$kgSO_4/m^3$
Description	Amount of the chemical oxidising agent – here only SO_4- in the POME entering the anaerobic digester tanks
Source of data	Sampled
Value(s) applied	Assumed 1% of total organic materials removed in the digester tanks
Measurement methods and procedures	Sample of raw POME will be collected and analysed using internationally/nationally accepted methods. The analysis results will be forwarded to the plant engineer for verification and record keeping. The sampling will be analysed daily in the in-house laboratory for a period of one month to observe the fluctuation pattern of chemical oxidising agents ($kgSO_4/m^3$) in the POME. If there is no fluctuation on the monitored value of the parameter during the period of one month, the parameter can be monitored by taking one sample per month. The sulphate content will be considered as major fluctuation if the concentration exceeds 5000mg/l continuously for more than three times. In this case, the sulphate content will be monitored daily.
Monitoring frequency	
QA/QC procedures	The sample will be analysed once in a month by an external accredited laboratory. The uncertainty level of the data will be low.
Purpose of data	
Additional comment	Chemicals are not added in the process and SO_4- is a naturally occurring substance in POME. Therefore, there is no chemical oxidising agent entering the system boundary and continuous monitoring of chemicals added is not relevant in this process. However, as SO_4^{2-} occurs naturally, the amount will be monitored. A concentration of 5,000 mg/l is selected as the maximum allowance in the POME raw sample since the sulphate levels below 5,000 mg/l have no significant effect on methanogenesis process *(Zaid et al.)* 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 0.1% reflecting the amount of the COD oxidised by SO_4 .The assumption that 1% of the organic matter is oxidised by H_2S is thus very conservative. All data will be archived for throughout the crediting period and two years after that.

Data / Parameter	ID16: Q_{POME_bypass}
Unit	m^3
Description	Volume of POME entering the current water treatment system, bypassing the new wastewater treatment facility
Source of data	Measured
Value(s) applied	0
Measurement methods and procedures	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.
Monitoring frequency	
QA/QC procedures	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.
Purpose of data	
Additional comment	No such bypass is foreseen as this would not be allowed according to the approval from the Department of Environment, but if a bypass is established a flow meter will be installed

Data / Parameter	ID17: E_{CH4_leaks}
Unit	%
Description	Methane emissions from leaks in the biogas pipeline delivery system
Source of data	Measured
Value(s) applied	Zero.
Measurement methods and procedures	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.
Monitoring frequency	
QA/QC procedures	Annual checks to be carried out to international standards. Uncertainty level of the data is expected to be low.
Purpose of data	
Additional comment	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 Level of uncertainty for data is expected to be medium

Data / Parameter	ID18a: $W_{sludge,COD,m}$
Unit	t COD/t sludge
Description	Chemical oxygen demand in the sludge disposed after the dewatering process in month m
Source of data	Calculated based on samples by project participants
Value(s) applied	0.1491
Measurement methods and procedures	COD of the sludge will be measured monthly following international recognised standard method by MS-ISO 17025 accredited laboratory. In the event that data is not available for a particular month or period, monitoring data before and/or after the affected period would be used. The highest test value will be applied in the calculation during the month or period when data is not available. Data will be archived electronically, minimum for two years, after last issuance of CERs.
Monitoring frequency	Continuous measurement
QA/QC procedures	Uncertainty level of data is low. Sampling and testing will be carried out adhering to internationally recognised procedures
Purpose of data	Calculation of project emissions
Additional comment	Project emissions from sludge removed from the project activity system is considered in accordance with formulae in methodology ACM0014 version 05.0.0. Since there is no provision in AM0022 to calculate CH_4 emissions from sludge dispose, ACM0014 is referred. Formula for calculation is showed in section B.6.1.

Data / Parameter	ID18b: $W_{N,sludge,m}$
Unit	t N/t sludge
Description	Mass fraction of nitrogen in the sludge
Source of data	Measurement
Value(s) applied	0.002
Measurement methods and procedures	Mass fraction of nitrogen in the sludge will be measured monthly following international recognised standard method by MS-ISO 17025 accredited laboratory. In the event that data is not available for a particular month or period, monitoring data before and/or after the affected period would be used. The highest test value will be applied in the calculation during the month or period when data is not available. Data will be archived electronically, minimum for two years, after last issuance of CERs.
Monitoring frequency	Monthly
QA/QC procedures	Uncertainty level of data is low. Sampling and testing will be carried out adhering to internationally recognised procedures
Purpose of data	Calculation of project emissions
Additional comment	Project emissions from sludge removed from the project activity system is

	considered in accordance with formulae in methodology ACM0014 version 05.0.0. Since there is no provision in AM0022 to calculate N_2O emissions from sludge dispose, ACM0014 is referred. Formula for calculation is showed in section B.6.1.

Data / Parameter	ID19: S_m
Unit	t sludge
Description	Amount of sludge dispose per month
Source of data	Measurement
Value(s) applied	121.555 Based on following assumptions: (i) estimated POME volume = 270,000 m^3/yr; (ii) suspended solid concentration in treated POME = 1.96 kg/m^3
Measurement methods and procedures	Amount of sludge dispose would be measured by weighbridge(s) of the mill. Data will be archived electronically, minimum for two years, after last issuance of CERs.
Monitoring frequency	Continuously
QA/QC procedures	Uncertainty level of data is low. Measurement equipment would be subject to annual calibration.
Purpose of data	Calculation of project emissions
Additional comment	-

Data / Parameter	ID20: T_{flare}
Unit	^oC
Description	Temperature in the exhaust gas of the flare
Source of data	Measurement by project participants
Value(s) applied	> 500 ^oC
Measurement methods and procedures	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.
Monitoring frequency	
QA/QC procedures	Thermocouples should be replaced or calibrated yearly.
Purpose of data	
Additional comment	Data shall be archived during the crediting period and at least 2 years after the crediting period.

Data / Parameter	ID20a: Other flare operation parameters
Unit	-
Description	This should include all data and parameters that are required to monitor whether the flare operates within the range of operating conditions according to the manufacturer's specifications.
Source of data	Measurements
Value(s) applied	
Measurement methods and procedures	Monitor continuously all data and parameters indicating the operating conditions of the flare according to the manufacturer's specifications. Parameters to be monitored would be determined from the Technical Specifications provided by the manufacturer. Data will be archived electronically, minimum for two years, after last issuance of CERs.
Monitoring frequency	
QA/QC procedures	Engineer-in-charge to verify regularly the monitoring records of the operators.
Purpose of data	
Additional comment	

Data / Parameter	ID22: $\sum EC_{PJ,y}$
Unit	MWh
Description	Total electricity consumed by the project activity
Source of data	Measured
Value(s) applied	0
Measurement methods and procedures	The total electricity consumed by the project activity would be measured continuously by the power meter installed. Log-sheets would be used to record the electricity consumption by the project activity. Operator would indicate/record in the log-sheet the time the boilers start operation and stop. Electricity consumed by the project activity between the time boilers stop and start would be considered as electricity imported from grid, which would be used for calculation of $PE_{EC,y}$.
Monitoring frequency	
QA/QC procedures	The power meter is subject to annual verification/calibration that will be done 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.
Purpose of data	
Additional comment	Data shall be archived during the crediting period and at least 2 years after the crediting period.

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

- **ID. No.8 -** Fossil fuel volume equivalent to generate the same amount of heat generated from the biogas collected in the anaerobic treatment facility

The biogas is sent to the biomass boiler and there is thus no replacement of onsite fossil fuel for heat production.

- ID No. 10 – Biogas sent to gen set / gas engine. Sungai Kerang project site does not use gas engine. All biogas produces will be used in the boiler to generate steam and power in the turbine

- **ID No 14 -** Genset combustion efficiency.
This ID in not relevant as there will not be any genset or gas engines in this project activity. All the biogas produced will be combusted in the boilers.

- ID No 19 Net Calorific Value (NCV) of biogas
Since the biogas is not used for heat production it is not a relevant factor.

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 sent to	Low	Yes	The biogas flow meter is subject to annual calibration that will be done by

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
	facility heater, in this case, the boiler			the manufacturer and in accordance to appropriate industry standards to ensure accuracy. Records of calibration will be kept at site.
7.	Power production from the gas turbine	High	Yes	Cross check with biogas generated in the digesters
9.	Biogas combustion process volume in flaring	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 measurement and calculation of flare efficiency. The results will be compared with previous values for consistency
13.	Oxidizing chemical agents entering system boundary	Low	Yes	Sample will be sent to external lab once in a month.
15	Heating System Combustion Efficiency	Medium	Yes	Procedures of the accredited laboratory and supplemented with comparison of results from previous years and IPCC default values
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 doe 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
18.	COD leaving the anaerobic digester tanks 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 send to appointed SAMM accredited laboratory.
20.	Temperature in	Low	Yes	The type N thermocouple unit is

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
	the exhaust gas of the flare			subject to annual calibration that will be done by the manufacturer and in accordance to appropriate industry standards to ensure accuracy or replace yearly. Records of calibration will be kept at site.

B.7.2. Sampling plan

>>

Not applicable.

B.7.3. Other elements of monitoring plan

>>

This Monitoring plan will set out a number of monitoring tasks in order to ensure that all aspects of projected greenhouse gas (GHG) emission reductions for the proposed project are controlled and reported.

This requires an on going monitoring of the project to ensure performance according to its design and that claimed Certified Emission Reductions (CERs) are actually achieved.

The monitoring plan of the proposed project is a guidance document that provides the set of procedures for preparing key project indicators, tracking and monitoring the impacts of the proposed project. The monitoring plan will be used throughout the defined crediting period for the project to determine and provide documentation of GHG emission impacts from the proposed project. This monitoring plan fulfils the requirement set out by the Kyoto Protocol that emission reductions projects under the CDM have real, measurable and long-term benefits and that the reductions in emissions are additional to any that would occur in the absence of the certified project activity.

Key definitions

The monitoring plan will use the following definitions of monitoring and verification.

Monitoring: The systematic surveillance of the project's performance by measuring and recording of performance-related indicators relevant in the context of GHG emission reductions.

Verification: The periodic ex-post auditing of monitoring results, the assessment of achieved emission reductions and of the project's continued conformance with all relevant project criteria by a selected Designated Operational Entity (DOE).

<u>Objective</u>

The monitoring plan is important as it shall establish a reliable and accurate monitoring system. The skilled and semi-skilled workers employed would follow the outlined monitoring plan, regular maintenance and calibration schedule, data verification and troubleshooting methods. The monitoring plan shall serve the purpose of being a guide to meet the yearly verification and certification of CERs.

The monitoring plan provides the requirements and instructions for:

1. Establishing and maintaining the appropriate monitoring systems for electricity generated by the

project;
2. Quality control of the measurements;
3. Procedures for the periodic calculation of GHG emission reductions;
4. Assigning monitoring responsibilities to personnel;
5. Data storage and filing system;
6. Preparing for the requirements of an independent, third party auditor or verifier.

The plant engineer is in charge of the implementation of this Monitoring Plan and summarizing the results. The General Manager of Sungai Kerang Sdn. Bhd. Will check the results to ensure the quality and accuracy of the data monitored .The monthly summary will be prepared by the Plant Manager and calculate the emission reductions of the proposed project and develop reports with the support from their CDM consultant.

Key Persons Responsibilities of the proposed project in Sungai Kerang Development Sdn Bhd

1. Managing Director

   Confirming the values and data summarized by the Mill Manager for the issuance of CER.

2. Mill Manager

   Overall management of the implementation of the monitoring plan and quality control of data and records. To calculate emission reductions based on monthly summary and advice the Managing Director on amount of emission reductions achieved. .

   To check the results of all data monitored and to ensure the quality and accuracy of the data monitored

3. Plant Executive – Biogas Department

   Overall in charge of implementation of the monitoring plan and summarizing the results. To oversee all supervisors or operators in charge of taking down and maintaining the monitoring parameters.

4. Purchasing Department – Officer

   Overall in charge of FFB grading and control of weighbridge. In charge of calibration of all weighbridge and compiling a monthly report for the General Manager.

5. Maintenance Supervisor

   Overall in charge of recording any down time and maintenance work to the power plant.

6. Electrical Chargeman

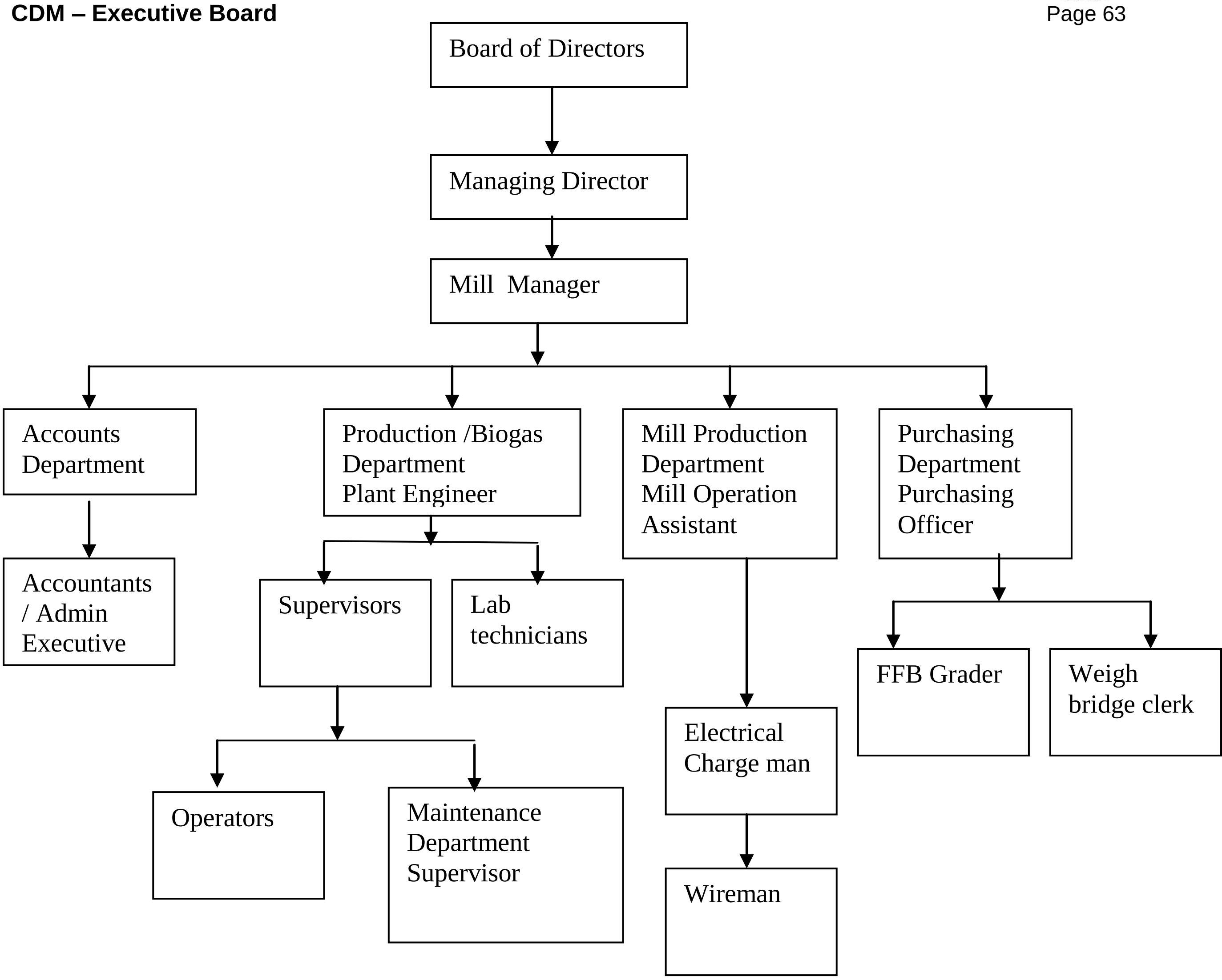
   In charge of the monitoring of electricity meters and calibration, fossil fuel consumption within the biomass plant (If any is used as back up) including boilers and generator set.

7. Accounts and Admin Executive

   Cross checking the monitoring records with receipt and procurement records.

The figure below outlines the operational and management structure that Sungai Kerang Development Sdn. Bhd. Will implement to monitor emission reductions and any leakage effects generated by the project activity.

Monitoring reports will be forwarded to and reviewed by the mill manager on a monthly basis in order to ensure the Project follows the requirements of the monitoring plan.



Quality Assurance

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

Quality assurance is under supervision of General Manager, assisted by the plant engineer

- Appointment of accredited laboratories, purchase good quality measurement devices;
- Appropriate training for staffs handling the monitoring;
- Clear procedures and guidelines for conducting the monitoring, including sampling and measurement methods, clear scheduling, recording, reporting and others;
- All reports, data, communications and information shall be centralized through the use of a computer network server and the various regional centers shall be connected through the internet to the Head Office so that the information can be captured promptly and accurately.
- Provision of internal review, quality check and assurance procedures with a quality assurance manager appointed. Regular calibration;
- Clear preventive and corrective actions to be prepared.

Data Storage

All data will be stored electronically and in paper at the plant during the crediting period and two years after that under the preview of mill manager. Data storage will be handled by the Admin executive and approved by the General Manager.

SECTION C. Duration and crediting period

C.1. Duration of project activity

C.1.1. Start date of project activity

>>

12/9/2007

Based on the quotation and work order issued for the foundation work for Sungai Kerang Development Sdn. Bhd. As stated in Section B.5

C.1.2. Expected operational lifetime of project activity

>>

20 years based on the e-mail correspondence with the technology provider.

C.2. Crediting period of project activity

C.2.1. Type of crediting period

>>

Fixed crediting period

C.2.2. Start date of crediting period

>>

01/04/2009. The crediting period shall start after the registration of the project.

C.2.3. Length of crediting period

>>

10 years

SECTION D. Environmental impacts

D.1. Analysis of environmental 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.

Steel tanks and steel piping system, which are widely known to withstand very low to very high pressure gas storage and transfer are used in the construction of the Biogas plant in the present project activity. This would minimize the possibility of physical leakage from the anaerobic digester system.

The fabrication and installation of the digester tanks will follow the relevant Technical and Engineering Specification and Standards. With proper engineering welding, the tank is guaranteed to provide 100% seal over the operational life of the project.

A report of the hydrostatic testing and gas leakage testing of the biodigester tanks provide negligible leakage of the tanks during commissioning will be provided to the owner.

The biogas system consultant has proposed 2 types of safety procedures:

a) Safety during construction of biogas system
b) Safety during daily operations of biogas system.

The safety procedure for site engineering works will be followed, and these include:

1. During construction of the biogas plant
    - The team of engineering supervisors and workers engaged would have prior experience on similar engineering works and therefore prior training on the safety procedures will be provided for the new workers.
    - The workers will be provided with the necessary safety tools and equipments such as hard hats, safety shoes, safety harness and gloves, no smoking at site, etc.
    - Prominent safety signs at worksite
    - Use of proper equipment and tools at work.
    - Training on fire fighting and emergency response.
    - Regular inspection of workers safety at work by supervisors.

2. During daily operations of the biogas plant system:
    - Training on safety rules provided to plant engineers, supervises, operators and laboratory staff will form part of t he overall company – wide safety measures as use of hard hats and safety shoes in certain areas, no smoking at site, fire and explosion risks, health risk, etc where applicable.
    - Prominent display of safety signs at work site.
    - Training on fire fighting and emergency response.
    - Regular inspection of workers safety at work.

3. A section covering “Safety Procedures” will be provided with the Operation Manual of the Biogas Plant System.

-

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. Environmental impact assessment
>>
Not applicable

SECTION E. Local stakeholder consultation
E.1. Solicitation of comments from local stakeholders
>>
A stakeholder meeting was held for the above project on 17th July 2007 at the premises of the Sg. Kerang Development palm oil mill in Gelong Pepuyu, off Bota, Perak. In addition to the management and staff, there were representatives of the Department of Environment, District and Land Office, village committees, consultants, millers and local residents. Letters were sent out to the stakeholders that had been identified earlier. The invites were followed up with calls to confirm attendance. The meeting was attended by 23 participants.

The following is a breakdown of the attendance at the meeting:

Department/Organisation	***Representatives***
Sg. Kerang management and staff	6
Consultants	5
Department of Environment	1
District and Land Office	1
Millers and suppliers	3
Village committee heads	3
Local residents	4
TOTAL	**23**

Presentation

Ms. Bhavna first introduced participants to the Clean Development Mechanism as one of the mechanisms to address the reduction of greenhouse gas emissions. She informed participants that so far, Malaysia has registered 12 CDM projects, mostly involving bio source waste used for energy generation. Her presentation also explains more on advantages of CDM projects and support by Malaysian government on establishing CDM projects as a source of sustainable development.

Mr. Adnan then proceeded to explain the project description and activities. The proposed project is utilization of captured biogas from closed anaerobic digesters for on-site steam generation. Topics explained inclusive of current situation disadvantages and proposed future project's advantages and results. The presentation also explained how the role of CDM makes this project viable. He also incorporated information explaining that the project implementation shall assist in improving overall POME treatment quality, thus ensuring cleaner down-stream river.

E.2. Summary of comments received
>>

The following issues were raised by the participants. They were addressed by Dr. Tong Soo Loong (Novaviro Technology Sdn. Bhd.) and Mr. Adnan.

Mr. Ramli Abdullah, Department of Environment Perak

B. How much effluent from this mill is used for this biogas project?

100% effluent will enter the new anaerobic digesters.

2. Are these new tanks going to take up a lot of space?

The space taken up is less than the anaerobic ponds. Just for the 4 tanks and some fittings and pumps.

B. Any JAR test (Experimental Laboratory Test) done by technologist to test COD reduction efficiency?

Not necessary as the technology is established for more than 20 years. A recent project in Lumut has been operating for past 9 months and has complete sets of BOD and COD data.

B. The mill currently can meet the very stringent 20 mg/l BOD limit. Does installation of anaerobic digester affect the water quality?

Not at all. The system is expected to further improve the water quality.

B. Question was asked on the first mill that implemented the biogas technology.

The biogas plant in Keck Seng Mill, which has been operating since past 20 years (no CDM then). The biogas plant was necessary built because the mill was located next to a refinery (belonging to the same group) which has a high pressure boiler using the high value diesel fuel. So, the biogas production substitutes the diesel fuel dependency.

B. Is the project intended for long-term?
Yes. The mill recently upgraded POME treatment with the addition of a Sequential Batch Reactor which improved water quality. The new project shall ensure the current situation continues.

B. What is the estimated cost of setting up the biogas plant?

Typically the smallest (30 tFFB/hr plant) needs an investment of 2.7- 3 million Ringgit Malaysia. This figure increases, though not in proportionate as the plant capacity increases. Thus, without funding assistance from CDM, the project is not viable.

B. Is this inclusive of cost for upgrading to high efficiency boiler/gas engine?
No.

Mr. Hisham, Village Head

B. How long is project construction period?
Approximately 9 months inclusive of application for approvals and construction works. The construction work will incorporate local supply and man-power.

En Osman (Kg. Manja)

10. *There are now around 120 houses in Kg. Manja with 60 of them by the riverside. Just 3 years ago the river was very smelly and dirty, with there were no fish living in the waters. Now he thanks the DOE and the management of Sg Kerang Palm Oil Mill Management for treating the effluent water and improving*

further their effluent treatment as the water is no longer smelly and there are fish breeding in the water. It gives them assurance the river will not be polluted as before.

The meeting was adjourned at 4.30 pm and participants were informed that they could also submit questions on the project to Sg. Kerang Mill within a week.

E.3. Report on consideration of comments received
>>
There were no questions submitted to the Sungai Kerang office within one week of the stakeholders meeting and no issues raised.
Since there were no objections, there was no need to change the project or the project implementation.

SECTION F. Approval and authorization
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Appendix 1: Contact information of project participants

Organization name	Sungai Kerang Development Sdn Bhd
Street/P.O. Box	Jalan Gelong Pepuyu Bota
Building	
City	Sitiawan
State/Region	Perak
Postcode	32000
Country	Malaysia
Telephone	++ 605 – 376 5541/42/43
Fax	++ 605 – 376 5540
E-mail	skerang@pd.jaring.my
Website	
Contact person	
Title	Managing Director
Salutation	Mr.
Last name	Teng Ye
Middle name	
First name	Ngan
Department	
Mobile	
Direct fax	++ 603 – 2162 2958
Direct tel.	++ 603 - 2121 8377
Personal e-mail	ngan@pop.jaring.my, ngan@nganholdings.com

Organization name	Mercuria Energy Trading SA
Street/P.O. Box	Rue du Rhone, 50
Building	
City	Geneva
State/Region	
Postcode	CH 1204
Country	Switzerland
Telephone	+41 (0)22 594 7000
Fax	+41 (0)22 594 7960
E-mail	emissions@mercuria.com
Website	
Contact person	
Title	
Salutation	Mr.
Last name	Fernandez de Mello e Souza
Middle name	
First name	Pablo
Department	
Mobile	
Direct fax	+41 (0)22 594 7000
Direct tel.	+41 (0)22 594 7960
Personal e-mail	

Appendix 2: Affirmation regarding public funding

No Funding Form an Annex 1 Country Government Has Been Involved In The Project

Appendix 3: Applicability of selected methodology

Refer to Section B.2 above for applicability of selected methodology.

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

Refer to Section B.6 above, under Baseline Calculations

Appendix 5: Further background information on monitoring plan

Refer to section B.7 above and the set of operational procedures developed by the project owner to be presented at the site validation

Appendix 6: Summary of post registration changes

No.	Section/Page	Changes
1	Cover page	Update information of project participants and revision to ex-ante ERs.
2	Section A.1: page 3; Section A.3: page 6& 7; Section B.3: page 14, 15 & 15	Revision to for sludge disposal
3	Section A.4: page 8	Revision/typo error correction to project participants' information.
4	Section B.6.1: page 30 & 33; Section B.6.3: page 44; Section B.6.4: page 46	Include description, formulae and calculation for project emissions due to disposal of sludge, revised project emissions (E_{PA}) and ex-ante ERs.
5	Section B.6.2: page 38	Improvement on description of "data/parameter" for EF_{CH4}
6	Section B.6.2: page 43	Added ex-ante parameter f_r (Heating system combustion efficiency). f_r of 99.66% would be used for ex-ante and ex-post ERs calculation.
7	Section B.7.1: page 54	Shifted ID15 (f_r) to ex-ante. Reason being destruction of CH_4 shall be taken as 100% efficiency if biogas is combusted for gainful purposes.
8	Section B.7.1: page 56 Section B.7.1; page 56 Section B.7.1: page 57	Revision to ID18 to ID18a ($W_{sludge,COD,m}$ (t COD/t sludge)) Added ID18b – $W_{N,sludge,m}$ for the calculation of project emissions from sludge disposal Added ID19 – S_m (amount of sludge dispose per month) The above parameters were revised/added for the calculation of project emissions due to disposal of sludge, reference to equation 16, 17 & 18 of ACM0014 version 05.0.0.
9	Section B.7.1: page 57 & 61	Deleted ID21 – in accordance with methodology V_{total} is not a monitoring parameter and it is not used in any of the calculation of baseline/project/leakage emissions.
10	Section B.7.3: page 62	Corrected typo error.
11	Appendix 1: page 70	Updated contact information of PP