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

CONTENTS

Annexes

SECTION A. General description of project activity

A.1 Title of the project activity:

Tradewinds Methane Extraction and Power Generation Project

Version No. : Version 6
Dated : 04/07/2007

A.2. Description of the project activity:

The project activity is the covering up of one of the existing anaerobic open ponds to capture methane-rich biogas from effluent generated at the palm oil mill. The captured methane generated by the wastewater treatment will be combusted to produce energy. This energy will replace the usage of diesel for power generation and will substantially reduce the mill's consumption of diesel. It is not projected at this point that electricity generation for export to the grid is a feasible option.

The mitigation potential of the project activity arises from the capture of methane, which is currently emitted from the open waste water ponds and from the displacement of diesel by combusting methane to produce energy.

The palm oil mill is currently operating diesel generator-sets to generate electricity during start-up or, when the boiler cannot maintain sufficient pressure to turn its turbines, or during mill shut down or maintenance and when the mill is not in operation to meet the power demand of workers living quarters. The project activity will reduce the running time of the diesel generator-sets and thus reduce greenhouse gas emissions from the diesel power generator.

The proposed project activity is to be implemented at Binu Palm Oil Mill (Binu) which has a production capacity of 45 tonnes of fresh fruit bunch (FFB) per hour, generating over 500 cubic meter of Palm Oil Mill Effluent (POME) every production day. The wastewater from the mill is treated through a ponding system consisting of 16 ponds, six of which are anaerobic ponds. The depth of the anaerobic ponds is about 5 m and the average atmospheric temperature in the region is about $30^{o}C$. These conditions result in anaerobic conditions within the ponds, resulting in methane generation from the biodegradation of the organic content in the wastewater. Figure A1 shows the existing configuration of the effluent treatment system.

The main carbon components of the POME are oil, glucose and xylose[1]. POME is expected to generate more CH_4 as existing practice is acidification of the POME before feeding into anaerobic ponds. Based on the study by Yacob *et al.*, 2006, an average of 0.238 $kgCH_4/kgCOD$ was emitted from anaerobic pond treatment of POME[2].

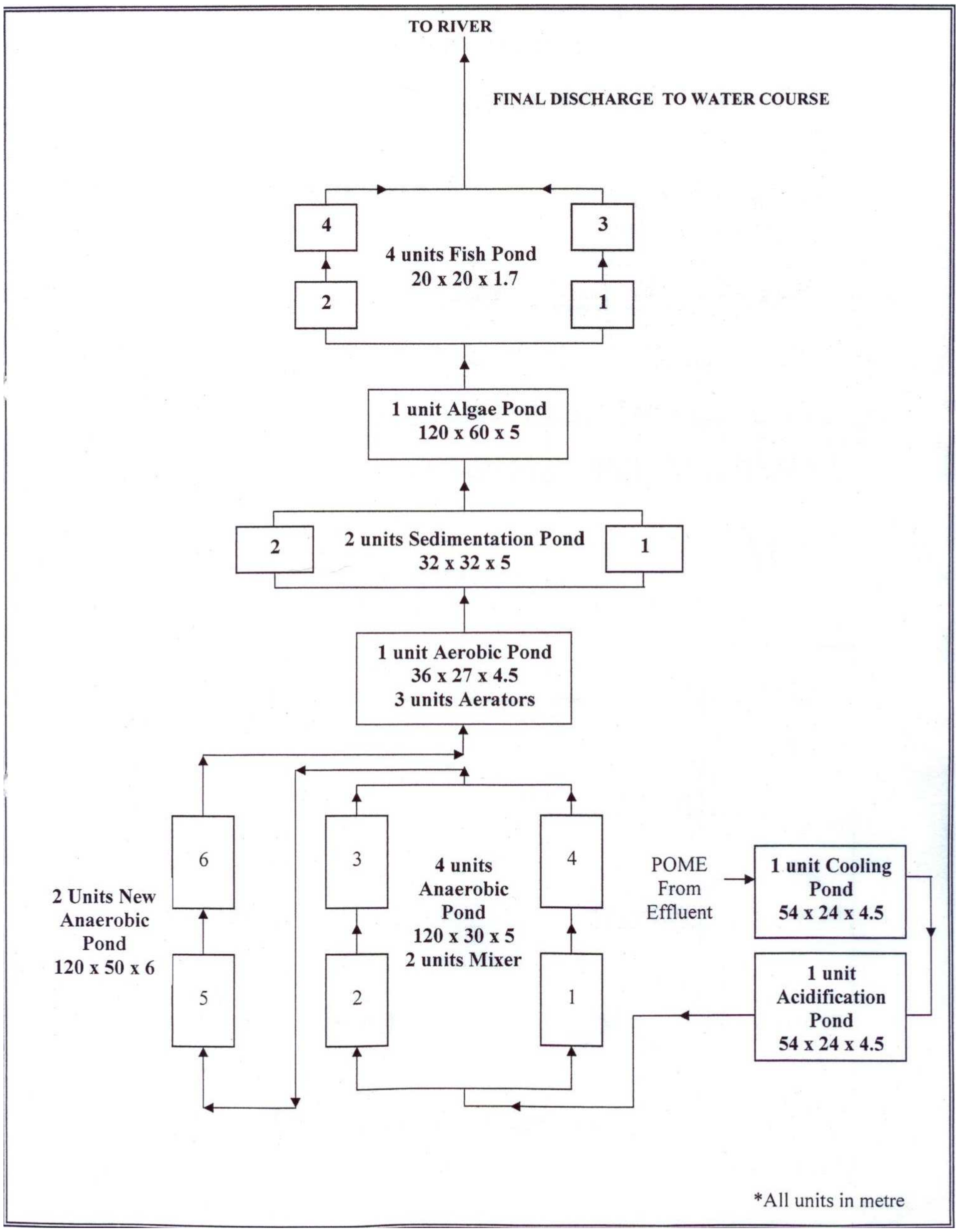

Figure A1. Existing Wastewater Treatment Layout

Sustainable development

The project will contribute to the use of sustainable renewable energy sources in place of fossil fuel. This is in line with the country's policy on the use of renewable energy as a fifth fuel. Currently diesel fuel is subsidized and the project will directly lead to a reduction in the use of subsidized diesel fuel in the industry.

The BioX energy system proposed for the project activity is developed and fabricated by BioX in the Netherlands. BioX have extensive experience and expertise in biogas handling and methane combustion using gas engines. The project will lead to technology and knowledge transfer to Malaysia. The project is expected to facilitate extensive use of biogas reactor as well as gas engines and establishment of local support for such systems. Being able to attain support locally, the project will ensure local employment and reduce the dependency on foreign expenditures.

Environmental sustainability

The Project is in line with the Malaysian Government's initiative to promote the use of Renewable Energy. This initiative is highlighted in the fifth fuel strategy under the country's Fuel Diversification Policy, as set in the objectives of the Third Outline Perspective Plan for 2001-2010 (OPP3)[3]. Renewable energy is utilized in this project by reducing the use of fossil fuel (diesel) and increasing the use of local renewable resources such as biogas. This will in some small way helps toward improving adequacy and sustainability of energy supply as envision by the Ninth Malaysia Plan (2006-2010)[4].

This project activity will have positive effects on the local environment by improving air quality through reduction of odor and cleaner emission. The project will be installed with extensive monitoring system and is designed to comply with all the local environmental regulations.

Social sustainability

Biogas reactors or digesters and gas engines are not widely used in Malaysia. Gas engines combusting biogas or methane is even considered as a rather problematic technology due to some previous bad experiences with running biogas in gas engines. Talk of engine fouling and corrosion from combusting biogas has frightened the local industries so much so that industries, particularly palm oil industry, are skeptical of the technology.

The transfers of knowledge and latest technology from BioX regarding biogas generation, trapping, scrubbing and the usage of biogas in gas engines are envisaged to counter this skepticism. To address this, the current workforce will be trained to operate the gas engine and qualified staff will be trained and employed.

The project will give an opportunity for the local population to adopt and acquire the latest knowledge of biogas capture and gas engine technology. BioX will ensure that training will be provided to the local workforce to maintain and service the system, which will improve the local manpower skills and provides an opening for employment or recruitment of more skilled staff.

Economic sustainability

The project is expected to stimulate the development both the market for gas engines in Malaysia and the use of biogas as a real alternative energy for the local industries. It is anticipated that the markets for other related supporting industries will develop to support this technology. On the long-term this will improve the adoption of the use of renewable energy sources in the local market.

The project will lead to economic sustainability, as the fuel source is a sustainable, from indigenous resources and reduces fossil fuel usage. This will indirectly reduce both fuel imports and negative impact on the foreign exchange. The project will also have a positive impact on the economic performance of palm oil refineries as their production will become more sustainable and efficient and eliminate the risks of fluctuating oil prices, which will enable a more economic reliable production in general.

A.3. Project participants:

(*) In accordance with the CDM modalities and procedures, at the time of making the CDM-PDD public at the stage of validation, a Party involved may or may not have provided its approval. At the time of requesting registration, the approval by the Party(ies) involved is required.

Name of Party involved (*) ((host) indicates a host Party)	**Private and/or public entity(ies) project participants (*) (as applicable)**	**Kindly indicate if the Party involved wishes to be considered as project participant (Yes/No)**
Malaysia (host)	Tradewinds Plantation Management Sdn Bhd BioX Carbon Malaysia Sdn Bhd	No No
The Netherlands	BioX Carbon BV	No
(*) In accordance with the CDM modalities and procedures, at the time of making the CDM-PDD public at the stage of validation, a Party involved may or may not have provided its approval. At the time of requesting registration, the approval by the Party(ies) involved is required.		

A.4. Technical description of the project activity:

A.4.1. Location of the project activity:

The project is located at Binu palm oil mill owned by Binu Plantations Sdn Bhd, a wholly owned subsidiary of Tradewinds Plantations Bhd.

A.4.1.1. Host Party(ies):

Malaysia

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

Sarawak

A.4.1.3. City/Town/Community etc:

Miri

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

Binu Palm Oil Mill is the proposed location of the project activity. This 45 ton per hour mill is located along the main Miri to Bintulu road about an hour drive from Miri City. The map indicates the location of the proposed site.

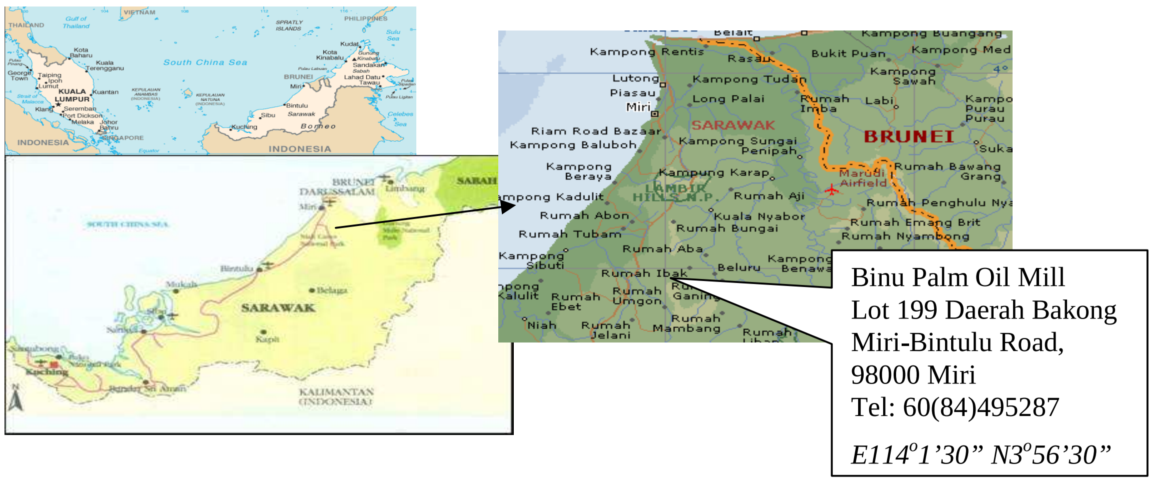

Figure A2. Location of Project Activity

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

The project activity is a methane avoidance project, which falls under "Scope 13 - Waste Handling and Disposal".

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

The technology to be employed by the project activity to capture methane is by means of installation of a cover over an existing anaerobic pond creating an active bioreactor. The system will essentially comprise of a covered pond creating a bioreactor with sufficient capacity and hydraulic retention time (HRT) to greatly reduce the volatile solids loading in the effluent. The cover consists of a synthetic tarpaulin geomembrane, which is secured by means of an anchor trench around the perimeter. The tarpaulin is well suited for use in this project as it is an excellent product for large applications with UV, ozone and chemical resistance protection. Captured gas under the cover will be removed, cleaned and combusted in gas engine to generate electricity. Processed effluent from the pond cells will be routed to the existing ponds before final discharge.

Figure A3 shows the proposed project activity to mitigate GHG emissions. The configuration consists of a methane gas collector over the bioreactor pond and a flaring system as well as a gas engine system to produce electricity. The flare is installed to burn excess methane not required by the gas engine generator set. A power source from the mill is connected to the Project Activity in case powers from the gas engine

is not available and a electricity meter will be in placed to record the total consumption by the project activity. Continuous power supply to the bioreactor and monitoring system is important to provide continuous agitation and control to ensure optimum condition in the bioreactor.

Sufficient care was taken to ensure that reliable and compatible components have been incorporated in the design of the biogas capturing system. The tarpaulin cover selected for the cover has a tensile and tear strength which far exceeds the flare over-pressure-release threshold. The flare combustion capacity was designed to exceed the estimated GHG production forecasts. The gas engine and generator size is determined by the base-load when the mill is not in operation. An audit of the mill indicated this off-operation power requirement to be in the region of 150-200kW.

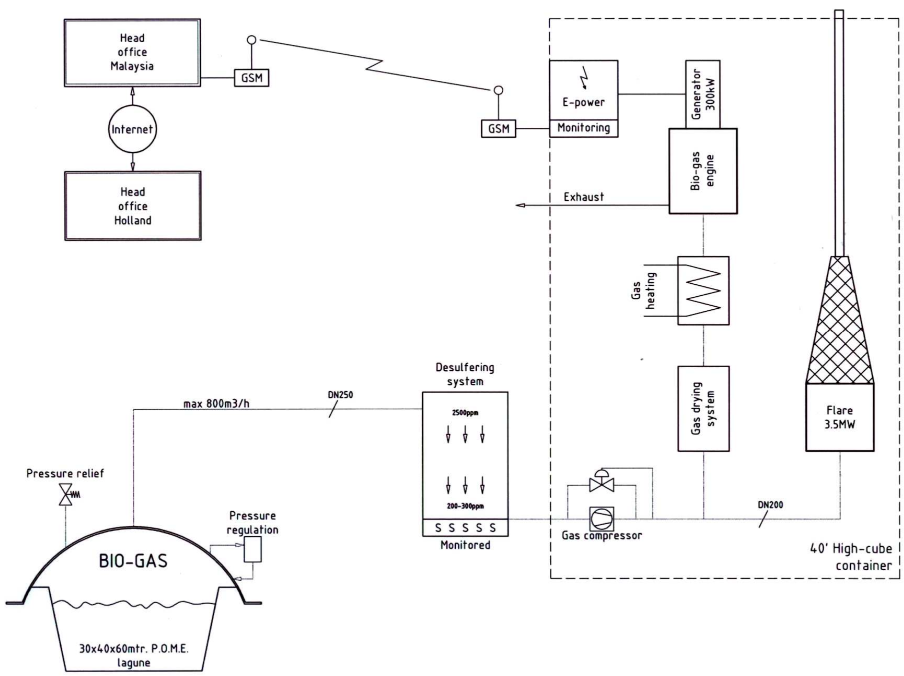

Figure A3. Schematic of Project Activity

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

Year	Annual estimation of emission reductions in tonnes of CO_{2e}
1st November 2007	4,041.2
2008	24,181.2
2009	24,181.2
2010	24,181.2
2011	24,181.2
2012	24,181.2
2013	24,181.2
2014	24,181.2
2015	24,181.2
2016	24,181.2
1st Jan – 31st October 2017	20,140.0
Total Estimated Reductions (tonnes of CO_{2e})	**241,812**
Total number of Crediting Years	**10**
Annual average over the crediting period of estimated reductions (tonnes of CO_{2e})	**24,181.2**

A.4.5. Public funding of the project activity:

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

SECTION B. Application of a baseline and monitoring methodology

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

This project activity utilizes the CDM approved baseline and monitoring methodology AM0022: “Avoided Wastewater and On-site Energy Use Emissions in the Industrial Sector.” Version 4, 22 December 2006.

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

The methodology specifically focuses on wastewater fugitive methane abatement through anaerobic digestion. The methodology was chosen because it offers GHG emissions baseline model that is applicable to the project activity as presented in the following table[5]:

Applicability criteria of AM0022	Project Activity
Project is implemented based upon a baseline of existing lagoon-based industrial wastewater treatment facilities for wastewater with high organic loading;	The mills currently are treating its highly organic wastewater in an open ponds system since the commissioning of the mills.
The organic wastewater contains simple organic compounds (mono-saccharides);	The organic waste water contains mainly large fraction of simple organic compounds[1] POME is expected to generate more CH_4 as existing practice is acidification of the POME before feeding into the open ponds. Based on the study by Yacob *et al.*, 2006, an average of 0.238 $kgCH_4/kgCOD$ was emitted from anaerobic pond treatment of POME[2]. Thus use of a 0.21 $kgCH_4/kgCOD$ CH_4 emission factor is justifiably conservative.
The methodology is applicable only to an existing wastewater treatment facility. It is not applicable for new facilities to be built, or new build to extend current site capacity;	The anaerobic ponds system has been in operation since the opening of all the mills. The project will not be implemented in a new waste water treatment capacity or expand the existing facility
It can be shown that the baseline is the continuation of a current lagoon system for managing wastewater. In particular, the current lagoon-based system is in full compliance with existing rules and regulations;	The baseline scenario will be further described in the analysis of the additionality of the project. An analysis of various options shows that continued use of the current lagoon to manage liquid waste disposal from the mills is the most likely baseline scenario. The open ponds system is the prevailing form of waste water treatment at Malaysian palm oil mill. The current wastewater ponding system was designed to meet the discharge requirement of the palm oil mill which was a main requirement for approval of license to operate. Consistently meeting the required limit however has been a huge struggle not only for this mill but for most mills in the industry. This is mainly due to the inconsistent nature of palm oil fruits and mill operation. Since the beginning of operation, the mill has had no problem in getting their yearly wastewater discharge license renewed. It must be noted that there is no requirement for biogas/methane capture in local wastewater treatment regulation.
The depth of the anaerobic lagoon should be at least 1 m;	The depth of the existing anaerobic ponds are about 5m
The temperature of the wastewater in the anaerobic lagoons is always at least 15 °C;	The average ambient temperature in Malaysia is about 25 – 30°C. The minimum temperature does not drop below 15°C.
In the project, the biogas recovered from the anaerobic treatment system is used onsite for heat and/or power generation, surplus biogas is flared;	The captured biogas would be combusted in a gas engine for power generation with excess biogas being flared.
Heat and electricity needs per unit input of the water treatment facility remain largely unchanged before and after the project;	The heat and power consumption per unit input of the waste water treatment plant does not change significantly due to the implementation of the project. Furthermore, the project activity would produce more than sufficient renewable electricity required by the project activity.

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 processes can be quantified (measured or estimated).	All the data required by the monitoring methodology can be easily obtained and measured. The ex post estimate is expected to be more accurate and reliable than the ex ante estimate

As the resultant baseline should be the continuation of current practice in the absence of CDM, the selection of approach 48(a) of the CDM modalities and procedures – existing actual or historic emissions are considered most appropriate for this project as the methodology is applicable to those projects whose baseline is the continuation of the current prevalent practice.

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

The main gas abated by the project activity would be methane which is produced in the anaerobic ponds due to the anaerobic degradation of organic load in the wastewater. The other gas that would be abated would be carbon dioxide that would be emitted from the diesel engine generator. In the project activity, the capture methane would be combusted in a gas engine generator to replace power generated by diesel.

	Source	Gas	Included	Justification / Explanation
Baseline	Anaerobic ponds	CO_2	No	Neutral CO_2 emissions from biomass
		CH_4	Yes	Methane emissions from anaerobic process
		N_2O	No	Not significant. Excluded for simplification and conservativeness
	Diesel generator	CO_2	Yes	CO_2 emissions from diesel burning
		CH_4	No	Not significant. Excluded for simplification.
		N_2O	No	Not significant. Excluded for simplification and conservativeness
Project Activity	Bioreactor	CO_2	No	Neutral CO_2 emissions from biomass
		CH_4	Yes	Methane emissions from anaerobic process
		N_2O	No	Not significant. Excluded for simplification and conservativeness
	Anaerobic ponds	CO_2	No	Neutral CO_2 emissions from biomass
		CH_4	Yes	Methane emissions from anaerobic process
		N_2O	No	Not significant. Excluded for simplification and conservativeness
	Gas engine	CO_2	No	Biomass based CO_2 emissions are considered neutral
		CH_4	Yes	The amount of methane gas combusted in the gas engine would be closely monitored.
		N_2O	No	Not significant. Excluded for simplification and conservativeness
	Flaring System	CO_2	No	Neutral biomass CO_2 emissions
		CH_4	Yes	The amount of methane gas combusted in the flare would be closely monitored.
		N_2O	No	Not significant. Excluded for simplification and

				conservativeness
	Palm Oil Mill Diesel generator	CO_2	Yes	CO_2 emissions from diesel burning
		CH_4	No	Not significant. Excluded for simplification.
		N_2O	No	Not significant. Excluded for simplification and conservativeness

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

The AM0022 methodology provide baseline determination methodology consisting of a six-step process to define the baseline and demonstrate that the continuation of current practices, existing open ponds anaerobic water treatment, is the baseline.

Utilising this six-step process, the baseline is identified as follows:

Step 1: Listing a range of potential baseline options

Plausible alternative for the baseline scenarios are:
1. Continuation of current practices (BAU)
2. Direct release of wastewater to a nearby water body
3. Aerobic treatment facility
4. Proposed anaerobic treatment facility not taken as a CDM project activity

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

The main types of barriers for project implementation can be classified as:
- Legal
- Technical
- Financial
- Social
- Business culture
- Others

The legal barrier is an absolute barrier in the sense that illegal options can not be the baseline. The technical and financial barriers are considered as the most significant barrier in any business investment decision. These barriers, either real or perceived, can lead to cultural barriers such as barrier against change in “common practice” even if the technical and financial barriers have been overcome.

The plausible alternative project activities identified in Step 1 are then analysed by assessing them against the identified barriers.

Legal Barriers

The current practice of wastewater treatment in open ponds system is the prevalent practice in palm oil mills in Malaysia with the allowable discharge level of biological oxygen demand (BOD) of 5,000 mg/l for land application and 100 mg/l for water way discharge[6,7]. The current wastewater ponding system in Binu POM was designed to meet the discharge requirement of the palm oil mill which was a main requirement for approval of license to operate. Consistently meeting the required limit however has been a huge struggle not only for this mill but for most of the mills in the industry especially Sarawak which has a discharge limit of BOD 20 mg/l for water way discharge instead of 100 mg/l in Peninsular Malaysia. This is mainly due to the inconsistent nature of palm oil fruits and mill operation. Since the beginning of operation, the mill has had no problem in getting their yearly wastewater discharge license renewed. It must be noted that there is no requirement for biogas/methane capture in local wastewater treatment regulation.

Direct release of wastewater into the nearby water bodies is not permitted and illegal. No further discussion is carried out regarding this option throughout the barriers analysis.

Both anaerobic and aerobic treatment system can achieve the same discharge standard requirement and would present a legal option. These options are not subject to additional regulation that requires the palm oil mill to use the system.

Legal issues are not considered a barrier to any of the really plausible scenarios.

Technical Barriers

The open ponds water treatment system which is used extensively in palm oil mills in Malaysia is an effective low-tech solution that can meet the water discharge limits applicable to the palm oil industry[8]. Ponds systems are the technology of choice palm oil industry as they are very low risk, and utilise low-tech redundancy suitable for remote installation that is typical for palm oil mills.

Though anaerobic ponds are used in existing wastewater treatment system, these are more like retaining ponds with minimal interference from the operator. The concept of capturing biogas from anaerobic ponds for energy is not readily acceptable in the palm oil industry. The few that have tried to harness the biogas has mixed result with one successful installation at Keck Seng Mill in Johor. Anaerobic systems are perceived as relatively high risk and with limited performance guarantee. The anaerobic system is seen as a high risk as it requires constant and ongoing precise management of a variety of elements such water flows, pH and temperature.

Aerobic treatment systems are used in Malaysian industrial wastewater treatment mainly for low organic load wastewater or where land price is a premium. Such a system is normally associated with high operating cost with high electricity consumption. As the existing systems can meet the legal discharge limit, there has been no push for the palm oil mills for such solutions.

Technology issues can be considered a major barrier to the anaerobic scenarios and mid-range barrier to the aerobic alternative and no barrier to the current ponds based management system.

Financial Barriers

The existing system is already installed and requires no further investment. To the Project Developer, the current system is financially attractive, given that it can comply with current regulation and requires virtually no management input to achieve the key parameter. Even with any future plant expansion, the current system has sufficient capacity to handle any additional waste.

Commercial risk is the most significant barrier to adopting waste to energy anaerobic technology at palm oil mill. This is amplified by the fact that palm oil mills have more than sufficient almost free power and only need minimal daily start-up power from diesel generators. The savings from the biogas power generation are not near enough to attract investment in such a system.

Aerobic treatment system would counter similar commercial risk as such a system would require constant supply of power to ensure proper operation. As palm oil mills only operate on 24 hours shift during high fruits season, such a system would require the mills to generate power from expensive diesel source during the non operation of the mills.

Financial barriers are considered to be a major barrier to the project scenario of adopting anaerobic waste to energy technology and a significant barrier to the aerobic waste management alternative.

Social Barriers

Where ponds systems are currently employed, apart from occasional complained of foul smell, few social barriers may be observed. These practices are accepted within the local community and are standard operation at palm oil mills in Malaysia as most of the mills are located at remote area. By installing the bioreactor and capturing the methane gas for electricity generation and flaring, odour smell will be reduced significantly.

Anaerobic and aerobic facilities present some social barriers of perceived risk mainly associated with new technology. For biogas capture in anaerobic system, the issue of safety is very much a concern in stakeholders' minds.

Social issues are therefore considered a minor barrier to the alternative scenarios and not a barrier to the current pond based management system.

Business Culture & Others

The current pond based treatment is considered standard operating practice in palm oil mills in Malaysia while the proposed project activity is not. The highest priority for most palm oil mill with regard to wastewater management is to simply maintain compliance with local regulation. Energy production, which is even more capital intensive and requires even greater management resources than the simple digestion process, is not a priority.

Business culture issues are considered a minor barrier to the alternative scenarios and no barrier to the current pond based management system.

Step 3: Score the barrier

Table 1: Barrier Test Framework

Barrier Tested / **Plausible Baseline Alternative**	**Direct release**	**Business as usual**	**Anaerobic gas capture**	**Aerobic treatment**
Legal Does the practice violate any host country laws or regulations or is it not in compliance with them?	**Y**	**N**	**N**	**N**
Technical Is this technology option currently difficult to purchase through local equipment suppliers?	**NA**	**N**	**Y**	**N**
Are skills and labour to operationalise and maintain this technology in the country insufficient?	**NA**	**N**	**Y**	**N**
Is this technology outside common practice in similar industries in the country?	**NA**	**N**	**Y**	**Y**
Is performance certainty not guaranteed with tolerance limits?	**NA**	**N**	**N**	**N**
Is there real or perceived technology risk associated with the technology?	**NA**	**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**	**N**	**Y**	**Y**
Is equity participation difficult to find locally?	**NA**	**N**	**Y**	**Y**
Are site owners/project beneficiaries carrying any risk?	**NA**	**N**	**Y**	**Y**
Is the proposed project exposed to commercial risk?	**NA**	**N**	**Y**	**Y**
Social Is the understanding of the technology low in the host country/industry considered?	**NA**	**N**	**Y**	**Y**
Business Culture Is there a reluctance to change to alternative management practices in the absence of regulation?	**NA**	**N**	**Y**	**Y**

Key – Y: barrier exists; N: barrier does not exist; NA: question is not relevant

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

The barriers analysis above identified the option with the least barriers which would represent the most likely baseline scenario. It clearly shows that the existing practice of open ponds system is the most plausible baseline scenario. For the other legal options, the most significant barriers are technology risk and financial risks. The other options would require further investment with added operational and maintenance costs as reflected by the relative lack of investment interest in such technologies.

Step 5: Investment analysis (if more than one plausible option)

Since only one option, business as usual, was found to be the most plausible baseline scenario; there is no need to do a financial comparison. However, a financial evaluation of the proposed project activity is done to further support the project additionality argument in Section B.5 below.

Step 6: Conclusion

Since the beginning of operation, the mill has had no problem in getting their yearly wastewater discharge license renewed by the Department of Environment, Malaysia. The open ponds system is the most common and standard practices of most palm oil mills in Malaysia. There is no legal requirement or motivational factor to compel mill owners to implement the other options that will require additional investment.

Therefore the continuation of existing open ponds system is the most likely baseline scenario as it requires no further investment and has the lowest technological risk.

B.5. Description of how the anthropogenic emissions of GHG by sources are reduced below those that would have occurred in the absence of the registered CDM project activity (assessment and demonstration of additionality):

As the baseline determination methodology in Section B.4 demonstrates that the baseline is the existing open ponds system, not the proposed project activity not undertaken as a CDM project activity, it can be concluded that the project is additional.

The implementation of this project activity is very much driven by the available incentive from the CDM. Without the incentive from CDM the project activity would not be implemented. The project activity was started in 27th October 2006 however the crediting period is only expected to start after the registration with the CDM Executive Board.

In Malaysia, the regulation that governs any environmental considerations including the wastewater treatment and discharge at palm oil mill is the Environmental Quality (Prescribed Premises) (Crude Palm Oil) Regulation 1977. The regulation stipulates the discharge standards for either water discharge or land application. The regulations however, do not specify the treatment technologies or requirement.

The palm oil sector is a very profitable industry that is so used to quick return on their investment. This is reflected in the industry higher expectations project Internal Rate of Return (IRR) for any investment that they undertake. Project IRR of 15% is regarded as a low benchmark for the palm oil sector[9].

The project activity is estimated to save the mill 75% of their diesel consumption for power generation. The project activity, without financing incentives from CDM gives a Non- Positive value of IRR (see Table B5.1). However, with CDM financing, the IRR would improves to 33% .

The proposed project activity is not an economically attractive course of action without the additional revenue from CER.

A sensitivity analysis was undertaken to examine the effects of different conditions on the economic analysis. Focus has been on identifying the parameters of most relevance for the "without CDM" situation. The following parameters were evaluated for sensitivity:

- The potential increase in cost of diesel, the predominant fossil fuel used in palm oil mills.
- Lower capital investment cost

Sensitivity analysis		
Price of Diesel RM/liter	**Project Activity without CDM**	**Project Activity with CDM**
	IRR	**IRR**
1.55	Non- Positive	36%
2.00	Non- Positive	39%
3.00	-14%	47%
5.00	13%	62%

Table B5.3: Sensitivity analysis for different diesel prices

Sensitivity analysis		
Reduction in investment cost	**Project Activity without CDM**	**Project Activity with CDM**
	IRR	**IRR**
10%	Non- Positive	38%
15%	Non- Positive	40%
20%	Non- Positive	43%
50%	Non- Positive	70%

Table B5.4: Sensitivity analysis for project activity at lower investment cost

A sensitivity analysis was performed to determine whether any variables or inputs could cause significant variations in the results. The sensitivity analysis results confirm that in an unrealistic scenario where all the variable parameters are taken as favourable to the project activity, the economic analysis still shows that the proposed project is not attractive if undertaken without CDM. The sensitivity analysis shows that the project IRR is only attractive if the cost of diesel reached above RM5.00 per liter. Though this scenario could happen in the future, it is not the prevailing condition now.

Even taking into account the inherent uncertainty of the financial analysis, the results give clear indication that there is a financial barrier for implementing the project without CDM. The project activity cannot be considered financially attractive unless with CDM financing.

In the absence of the project activity, the palm oil mill owners would not change their current practice. The palm oil mill owners do not have the motivation to change their waste water management system as there are no laws or regulatory directives driving such a change and even if they were so inclined, it has

been demonstrated that they would find the upgrade costs prohibitive. This further demonstrates the additionality of the project activity.

B.6. Emission reductions:

B.6.1. Explanation of methodological choices:

The methodology to be used is AM0022 "Avoided Wastewater and On-site Energy Use Emissions in the Industrial Sector". The proposed project activity meets all the applicability requirements stipulated by the approved methodology AM0022.

The estimation of project emissions was calculated based on the following:

Total project emissions:

$$E_{project} = E_{CH4\_lagoons} + E_{CH4\_NAWTF} + E_{CH4\_IC+Leaks} \quad (1)$$

where:

$E_{project}$: total project emissions (tCO_{2e})
$E_{CH4\_lagoons}$: fugitive methane emissions from subsequent lagoons after the 1st Bioreactor (tCO_{2e})
E_{CH4_NAWTF} : fugitive methane emissions from the new anaerobic waste water treatment facility
$E_{CH4\_IC+Leaks}$: methane emissions from inefficient combustion and leaks (tCO_{2e})

Applicability to this project

For this project, upon completion of anaerobic bioreactor (1st pond), the fugitive methane emissions from the subsequent lagoons will be calculated based on the size of the anaerobic lagoons (2nd to 6th ponds). Insignificant methane formation is expected from the Aeration pond where the conditions of the aeration pond are not favourable for anaerobes. The anaerobic bioreactor is expected not to emit any methane as the project will engage brand new pipe lines. However, for conservative estimation in this project, the fugitive methane emission from the new anaerobic waste water treatment facility (E_{CH4_NAWTF}) is estimated with leakage of 15% based on IPCC default value.

The following equation will be used for calculating the fugitive methane emissions:

$$E_{CH4\_lagoons} = M_{lagoon\_anaerobic} \cdot EF_{CH4} \cdot GWP_{CH4} / 1000 \quad (2)$$

where:

$M_{lagoon\_anaerobic}$: amount of organic material removed by anaerobic processes in the lagoon system (kgCOD)
EF_{CH4} : methane emission factor (0.21 $kgCH_4$/kgCOD)[2]
GWP_{CH4} : Global Warming Potential of methane ($GWP_{CH4} = 21$)

For methane emissions from inefficient combustion:

$$E_{CH4\_IC+Leaks} = \sum_r V_r . C_{CH4\_r} . (1 - f_r) . GWP_{CH4} - PE_{flare} \quad (3)$$

where:
The sum is made over the two predominant routes *r* for methane destruction (flaring and power generation).

V_r : biogas combustion process volume in route *r* (Nm^3)
C_{CH4} : methane concentration in biogas (tCH_4/Nm^3) to be measured on wet basis
f_r : proportion of biogas destroyed by combustion (-)
PE_{flare} : project emissions from flaring of the residual gas stream (tCO_{2e}) calculated following the procedures described in the *"Tool to determine project emissions from flaring gases containing Methane"*.

Applicability to this project
Methane emissions from inefficient combustion of gas engine is estimated based on supplier given data of 99% efficiency and will be determined annually during O&M downtime throughout the crediting period as required by the methodology. While for Enclosed Flare system, a default IPCC value of 90% will be used. Refer Annex 7 for manufacturer's specification on operating conditions of the enclosed flare system.

The mass balance in the considered lagoon system provides the amount of organic material removed by anaerobic processes:

$$M_{lagoon\_anaerobic} = M_{lagoon\_total} - M_{lagoon\_aerobic} - M_{lagoon\_chemical\_ox} - M_{lagoon\_deposition} \qquad (4)$$

Where,
M_{lagoon_total} : the total amount of organic material removed in the lagoon system (kgCOD)
$M_{lagoon\_aerobic}$: the amount of organic material degraded aerobically in the lagoon system (kgCOD). Surface aerobic losses of organic material in pond based systems equal to 254 kgCOD per hectare of pond surface area and per day is assumed to be lost through aerobic processes.
$M_{lagoon\_chemical\_ox}$: the amount of organic material lost through chemical oxidation in the lagoon system (kgCOD)
$M_{lagoon\_deposition}$: the amount of organic material lost through deposition in the lagoon system (kgCOD)

Total Material Removed In Lagoon System is:

$$M_{lagoon\_total} = M_{lagoon\ input} . R_{lagoon} \qquad (5)$$

where:
M_{lagoon_total} : Total amount of organic material removed in the lagoon system through various routes (kgCOD)
R_{lagoon} : Total organic material removal ratio of the lagoon. It is a project specific factor, and is equal to the proportion of organic material removed (through all routes) within the boundaries of the lagoon system under consideration.

Applicability to this project
The total organic material removal ratio was based on by Yacob *et al.*, 2006, approximately 97.8% COD removal ratio was achieved in anaerobic lagoons system[2]. The data was concluded based on a yearly (277 mill operating days) observation, sampling and testing of COD at anaerobic lagoons in Felda Palm Oil Mill. However, for Baseline calculation, a conservative figure of 95% removal rate is being used.

Material Deposition In Lagoon System is:

$$M_{lagoon\_deposition} = M_{lagoon\ input} . R_{deposition} \qquad (6)$$

where:
$R_{deposition}$: The organic material deposition ratio of the lagoon.

Applicability to this project
Since there are no chemical added during the process of FFB in palm oil mill, therefore the wastewater in the project case contains no compounds that would lead to chemical oxidation. The organic material lost through deposition is expected to be 5% as the lagoons are normally desludged once in few years time[13]. Furthermore, more than 95% of organic materials will be digested in the existing anaerobic ponds, therefore less than 5% of organic material will be deposited. In the Project Emission, the sludge deposition is expected to be lower since the wastewater in the bioreactor will have the stirring effect (well mixed) by pumping back methane gas into it.

Total Baseline Emissions:

The total baseline emissions can be calculated using the following formula:

$$E_{BL} = E_{CH4\_lagoons\_BL} + E_{CO2\_power\_BL} \qquad (7)$$

where:
E_{BL} : total baseline emissions (tCO_{2e})
$E_{CH4\_lagoons\_BL}$: fugitive methane emissions from anaerobic system in the baseline case (tCO_{2e}). It is calculated with baseline data based on equation (2) in the section on project emission
$E_{CO2\_power\_BL}$: CO_2 emissions related from power generation in the baseline case (tCO_2) that are displaced by generation based on biogas collected in this project

Baseline emission for electricity displacement can be calculated using following formulae:

$$E_{CO2\_power} = EL.CEF \qquad (8)$$

Where:
EL : Amount of electricity displaced by the electricity generated from the biogas collected from the anaerobic treatment facility.

CEF : Carbon emission factor for the electricity displaced by the electricity generated from the biogas.

For the total organic material in the baseline, the following can be assumed:

$$M_{input\_BL} = M_{input\_project} \quad (9)$$

where:

M_{input_BL} : total amount of organic material fed into the lagoons system (kgCOD)

$M_{input\_project}$: input of organic material to the new anaerobic bioreactor (kgCOD)

Leakage

Leakage is considered to be negligible.

The emission reduction of the project is calculated based on the following:

$$ER = E_{BL} - E_{project} \quad (10)$$

where:

ER : total emission reduction (tCO_{2e})

E_{BL} : total baseline emissions (tCO_{2e})

$E_{project}$: total project emissions (tCO_{2e})

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

Data / Parameter:	**Biogas Generation Potential**[2]
Data unit:	kg CH_4 per kg COD
Description:	The rate of conversion of COD to CH_4 within the wastewater
Source of data used:	IPCC recommended value
Value applied:	0.21 kg CH_4 per kg COD
Justification of the choice of data or description of measurement methods and procedures actually applied :	IPCC recommended value for similar wastewater condition. Study done by Yacob *et al.*, 2006, an average of 0.238 $kgCH_4$/kgCOD was emitted from anaerobic pond treatment of POME[2].
Any comment:	

Data / Parameter:	**Methane Global Warming Potential**
Data unit:	CO_{2e}
Description:	The equivalent in CO_2 of the effect of methane gas to the atmosphere
Source of data used:	UNFCCC Default value
Value applied:	21

Justification of the choice of data or description of measurement methods and procedures actually applied :	Global warming potential for methane gas since this is a methane capture project
Any comment:	

Data / Parameter:	Diesel electricity emission coefficient
Data unit:	$kgCO_2/kWh$
Description:	The emission attributed to diesel power generation
Source of data used:	IPCC default value
Value applied:	0.8
Justification of the choice of data or description of measurement methods and procedures actually applied :	Default value for CO_2 emissions based on kWh electricity being consumed since the palm oil mill running on diesel gen-set during start-up of operation.
Any comment:	

Data / Parameter:	Enclosed Flare efficiency
Data unit:	%
Description:	Biogas flaring efficiency for Enclosed Flares system
Source of data used:	Default value
Value applied:	90%
Justification of the choice of data or description of measurement methods and procedures actually applied :	Estimated 51.5% of excess biogas will be flared at Enclosed Flaring system. Continuous monitoring of compliance with manufacturer's specification will be performed.
Any comment:	

B.6.3 Ex-ante calculation of emission reductions:

Baseline Emissions

Baseline Assumptions:

1. Raw POME concentration is measured at average 50,000 mg/L[10]. During project implementation the actual COD of the inlet to the biogas bioreactor will be monitored and an ex post correction of the assumption will be made in the monitoring report to reflect the actual.
2. The average treatment efficiency of anaerobic lagoons is based on 95% (based on study done by Yacob *et al.*, 2006, COD removal rate in anaerobic ponding is 97.8%, in this Baseline calculation, only 95% removal rate is being used)[2].
3. The total surface areas of anaerobic lagoons (1st to 6th pond) is 26,400 m^2 (2.64 ha).
4. The amount of POME generated is 0.7 m^3/t Fresh Fruit Bunches (FFB)[11]
5. With the mill capacity of 45 mt FFB/hr running averagely of 5,000 hr/year, the mill is able to process up to 225,000 mt FFB/year and annual volume of POME discharge at 157,500 m^3 /year.

6. The deposition is assumed as 5% as the lagoons are normally only desludged once in few years time[13].
7. Since there are no chemical added during the process of FFB in palm oil mill, therefore the wastewater in the project case contains no compounds that would lead to chemical oxidation.

Calculation of Baseline Emission from existing Anaerobic Ponds System

$$M_{lagoon\_anaerobic} = M_{lagoon\_total} - M_{lagoon\_aerobic} - M_{lagoon\_chemical\_ox} - M_{lagoon\_deposition} \quad (4)$$

Total Organic Material Removed In Lagoon System

$$M_{lagoon\_total} = M_{lagoon\ input} . R_{lagoon} \quad (5)$$

$M_{lagoon\ input}$ = (157,500 m^3/year x 50.000 kgCOD/m^3)
= 7,875,000 kgCOD/year
R_{lagoon} = 95%

$M_{lagoon\ total}$ = 7,875,000 kgCOD/year x 95%
= 7,481,250 kgCOD/year

Surface aerobic losses
$M_{lagoon\_aerobic}$ = 254 kgCOD/day/ha x 2.64 ha x 365 days
= 244,754 kgCOD/year

Sulphate oxidation
$M_{lagoon\_chemical\_ox}$ = 157,500 m^3 /year x 0
= 0 kgCOD/year

Material Deposition In Lagoon System

$$M_{lagoon\_deposition} = M_{lagoon\ input} . R_{deposition} \quad (6)$$

$M_{lagoon\ input}$ = (157,500 m^3/year x 50.000 kgCOD/m^3)
= 7,875,000 kgCOD/year
$R_{deposition}$ = 5%

$M_{lagoon\_deposition}$ = 7,875,000 kgCOD/year x 5%
= 393,750 kgCOD/year

Total COD converted to methane
= 7,481,250 kgCOD/year – (244,754 + 393,750 + 0) t COD/year
= 6,842,746 kgCOD/year

Calculation of total baseline methane emissions

$$E_{CH4\_lagoons} = M_{lagoon\_anaerobic} \,.\, EF_{CH4} \,.\, GWP_{CH4} / 1000 \quad (2)$$

= (6,842,746 kgCOD/year x 0.21 $kgCH_4$/kgCOD x 21 $kgCO_{2e}$/$kgCH_4$) / 1000

= 30,176.508 tCO_{2e}/year

<u>Baseline emission for on site fossil power generation</u>

A biogas power generation system will be installed in the project activity to supplement the diesel on site power generation. The gas engine (300 kWh) is expected to only displace 75% of the total annual diesel consumption by the diesel generator of the mill (400 kWh). Based on the previous three (3) years data provided by the mill (Table B.6.3.1), the average consumption of energy is 644,403 kWh.

Year	kWh
2003	588,747
2004	811,934
2005	532,528
Average	**644,403**
Amount of electricity displaced (75%)	**483,302**

Table B.6.3.1: Mill three years historical diesel power generation

Assumption:

1. Based on IPCC Emission factor for $CEF_{electricity}$, for every kWh of energy consumed (diesel), 0.8 kg of CO_{2e} will be released to the atmosphere.

Calculation of Methane gas

Based on the calculation, 1,436.977 tCH_4/year can be produced in the Baseline.

Therefore, annual volume of Methane gas,

= (1,436.977 tCH_4/yr x 1000 kg/t) / 0.716 $kgCH_4/Nm^3$

= 2,006,951.1 Nm^3/yr

Net Calorific Value of CH_4,

= 2,006,951.1 Nm^3/yr x 35.8 MJ/Nm^3

= 71,848,849 MJ/yr

Liter of Diesel Equivalent[14],

= 71,848,849 MJ/yr / 35.144 MJ/l

= 2,044,412.9 l/yr

Based on the calculation, the project expected to produce enough methane for displacement of more than 2 million liter of diesel. Due to excess methane gas generated, part of the methane gas will be flared at site.

Calculation of baseline emission for onsite fossil power generation

$E_{CO2\_power} = EL.CEF$ *(8)*

Where:

EL : Amount of electricity displaced by the electricity generated from the biogas collected from the anaerobic treatment facility.

CEF : Carbon emission factor for the electricity displaced by the electricity generated from the biogas.

Therefore, Baseline Emissions for Diesel displacement (mill's diesel generator):

= 644,403 kWh x 75% x 0.8 kg CO_{2e}/kWh

= 386,642 kg CO_{2e}

= 386.642 t CO_{2e}/year

Calculation of total baseline emission

E_{BL} = $E_{CH4\_lagoons\_BL} + E_{CO2\_power\_BL}$ *(7)*

= 30,176.508 tCO_{2e}/year + 386.642 tCO_{2e}/year

= **30,563.15 tCO_{2e}/year**

Project Emissions

Project Assumptions:

1. The efficiency of biogas Bioreactor, R_T is assumed to be 95% and hence effluent into subsequent anaerobic lagoons could be 2,500 mg/l (= 50,000 mg/L x 0.05). This assumption will be verified ex-post and the actually achieved removal efficiency will be used in the monitoring report for calculation of the amount of CERs generated.
2. The average treatment efficiency of anaerobic lagoons is 70% (based on anaerobic lagoons treatment efficiency in Binu Tradewinds Mill).
3. The total surface areas of anaerobic lagoons (2nd to 6th pond) is 22,800 m^2 (2.28 ha) with the 1st anaerobic pond will be converted for biogas bioreactor.
4. The amount of POME generated is 0.7 m^3/t Fresh Fruit Bunches (FFB)[11]. With the present production level of 225,000 t FFB/year, the annual amount of POME is 157,500 m^3 /year.
5. The deposition is estimated at 5% as the lagoons are normally only desludged once in few years time[13].
6. Since there are no chemical added during the process of FFB in palm oil mill, therefore the wastewater in the project case contains no compounds that would lead to chemical oxidation.
7. Methane emission from inefficient combustion for Gas Engine is estimated based on supplier given data of 99% efficiency and will be determined annually during O&M downtime throughout the crediting period as required by the methodology.
8. Methane leakages from biogas system and pipelines are ignored in the project emissions estimation as the length of pipeline is less than 2 km and it using new high quality HDPE pipe. But all leakages would be monitored and if found to be significant (>1% of CER), it will also be accounted into project emission.

9. Emission (CO_2) from Electricity usage direct from the Mill for Project Activity during maintenance of gas engine or break down is assume to be negligible. However, it will be monitored & recorded through the electricity meter and accounted into project emission if any.
10. The new bioreactor anaerobic waste water treatment facility is expected not to have significant leakage. For conservative estimation, the emissions (leakage) is calculated based on IPCC default value of 15%.

Calculation of Project Emission from subsequent ponds

Applying the formulae (Formula 4, 5, 6 and 2) used in calculating baseline methane emission, the project methane emissions from the subsequent ponds is calculated.

$$M_{lagoon\_anaerobic} = M_{lagoon\_total} - M_{lagoon\_aerobic} - M_{lagoon\_chemical\_ox} - M_{lagoon\_deposition} \quad (4)$$

Total organic material removed in subsequent ponds

$$M_{lagoon\_total} = M_{lagoon\ input} . R_{lagoon} \quad (5)$$

$M_{lagoon\ input}$ = (157,500 m^3/year x 2.500 kgCOD/m^3)
= 393,750 kgCOD/year

R_{lagoon} = 70%

$M_{lagoon\ total}$ = 393,750 kgCOD/year x 70%
= 275,625 kg COD/year

Surface aerobic losses

$M_{lagoon\_aerobic}$ = 254 kgCOD/day/ha x 2.28 ha x 365 days
= 211,378.8 kgCOD/year

Sulphate oxidation

$M_{lagoon\_chemical\_ox}$ = 157,500 m^3 /year x 0
= 0 kgCOD/year

Material Deposition In Lagoon System

$$M_{lagoon\_deposition} = M_{lagoon\ input} . R_{deposition} \quad (6)$$

$M_{lagoon\ input}$ = (157,500 m^3/year x 2.500 kgCOD/m^3)
= 393,750 kgCOD/year

$R_{deposition}$ = 5%

$M_{lagoon\_deposition}$ = 393,750 kgCOD/year x 5%
= 19,687.5 kgCOD/year

COD removed from subsequent ponds after the biogas reactor
= 275,625 kgCOD – 211,378.8 kgCOD – 0 kgCOD – 19,687.5 kgCOD
= 44,558.7 kgCOD/year

Fugitive methane emissions from subsequent ponds
$E_{CH4\_lagoons} = M_{lagoon\_anaerobic} . EF_{CH4} . GWP_{CH4} / 1000$ (2)
= (44,558.7 kgCOD/year x 0.21 $kgCH_4$/kgCOD x 21) / 1000
= 196.504 tCO_{2e}/year

E_{CH4_NAWTF} **: fugitive methane emissions from the new anaerobic waste water treatment facility**

The anaerobic bioreactor is expected not to emit any methane as the project will engage brand new pipe lines. However, for conservative estimation in this project, the fugitive methane emission from the new anaerobic waste water treatment facility (E_{CH4_NAWTF}) is estimated with leakage of 15% based on IPCC default value. In V_r, surface aerobic oxidation is considered negligible as the bioreactor is being covered and sealed.

V_{Biogas_NAWTF} = CH_4 produced in bioreactor
= [(50 kgCOD/m^3 x 157,500 m^3 x 0.95) – Chemical Oxidation (157,500 m^3 x 0 kg/m^3) – Deposition (50 kgCOD/m^3 x 157,500 m^3 x 0.05)]/1000
= 7,481.25 tCOD/m^3 – 0 – 393.75 tCOD
= 7,087.5 tCOD x 0.21 tCH_4/tCOD
= 1,488.375 tCH_4 x 1000
= 1,488,375 $kgCH_4$ / 0.716 $kgCH_4/Nm^3$ CH_4
= 2,078,736 Nm^3 CH_4 / 0.544 Nm^3 CH_4/Nm^3 biogas (concentration of biogas)
= 3,821,205.8 Nm^3 biogas

C_{CH4_NAWTF} = 54.4% CH_4 concentration in biogas of ponding system based on Yacob *et al.*, 2006 (which is lower than normall`y reported at 60 – 65%)
= 0.544 Nm^3 CH_4/Nm^3 biogas
= [0.544 Nm^3 CH_4 x 0.716 $kgCH_4/Nm^3$ CH_4] / Nm^3 biogas
= 0.389504 $kgCH_4/Nm^3$ biogas / 1000
= 0.000389504 tCH_4 / Nm^3 biogas

Leakage = 15% IPCC default value

GWP_{CH4} = 21
E_{CH4_NAWTF} = 3,821,205.8 Nm^3 x 0.000389504 tCH_4/Nm^3 x 15% x 21
= 4,688.38 tCO_{2e}/year

Methane emissions from inefficient combustion

Methane emission from incomplete burning at the gas engine is estimated based on supplier given data of 99% burning efficiency while 10% IPCC default value for Enclosed Flaring system. In V_r, surface aerobic oxidation is considered negligible as the bioreactor is being covered and sealed.

$$E_{CH4\_IC + Leaks} = \sum_r V_r . C_{CH4\_r} . (1 - f_r) . GWP_{CH4} + PE_{flare} \quad (3)$$

Based on supplier's specification for Gas Engine, a 300 kWh gas engine need to have 180 Nm^3/hr of biogas at 60% concentration of methane.

Therefore, volume of biogas required by Gas Engine
= 180 Nm^3/hr x 24 hr/d x 365 d/yr
= 1,576,800 Nm^3/yr

Volume of CH_4 channel to Gas Engine and Enclosed Flare system after NAWTF

$V_{r\ (from\ bioreactor)}$ = CH_4 produced in bioreactor – E_{CH4_NAWTF}
= [(50 kgCOD/m^3 x 157,500 m^3 x 0.95) – Chemical Oxidation (157,500 m^3 x 0 kg/m^3) – Deposition (50 kgCOD/m^3 x 157,500 m^3 x 0.05)]/1000 – E_{CH4_NAWTF}
= (7,481.25 tCOD/m^3 – 0 – 393.75 tCOD) – E_{CH4_NAWTF}
= (7,087.5 tCOD x 0.21 tCH_4/tCOD) – E_{CH4_NAWTF}
= [(1,488.375 tCH_4 x 1000) / 0.716 $kgCH_4/Nm^3$] – E_{CH4_NAWTF}
= (2,078,736 Nm^3 CH_4 / 0.544 Nm^3 CH_4/Nm^3 biogas) – E_{CH4_NAWTF}
= 3,821,205.8 Nm^3 biogas x (1 – 15%)
= 3,248,024.9 Nm^3 biogas

$V_{CH4\ (from\ bioreactor)}$ = 2,078,736 Nm^3 CH_4 – 15% loss in NAWTF
= 1,766,925.6 Nm^3 CH_4

Therefore, percentage of biogas consume by Gas Engine and Enclosed Flare system:

Gas Engine = (1,576,800 / 3,248,024.9) x 100%
= 48.5%

Enclosed Flare = 1 – 48.5%
= 51.5%

C_{CH4_r} = 54.4% CH_4 concentration in biogas of ponding system based on Yacob *et al.*, 2006 (which is lower than normally reported at 60 – 65%)
= 0.544 Nm^3 CH_4/Nm^3 biogas
= [0.544 Nm^3 CH_4 x 0.716 $kgCH_4/Nm^3$ CH_4] / Nm^3 biogas
= 0.389504 $kgCH_4/Nm^3$ biogas / 1000

= 0.000389504 tCH_4 / Nm^3 biogas

f_r = 99% based on specification from the suppliers for gas engine

GWP_{CH4} = 21

$E_{CH4\_IC + Leaks}$ for Gas Engine
= 3,248,024.9 Nm^3 x 0.000389504 tCH_4/Nm^3 x (1 – 99%) x 21 x 48.5%
= 128.852 tCO_{2e}/year

Project Emissions for enclosed flaring using default value:

$$PE_{flare,y} = \sum_{h=1}^{8760} TM_{RG,h} \times (1 - \eta_{flare,h}) \times \frac{GWP_{CH_4}}{1000}$$

$$TM_{RG,h} = FV_{RG,h} \times fv_{CH_4,RG,h} \times \rho_{CH_4,n}$$

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

Where,
$PE_{flare,y}$: Project emissions from flaring of the residual gas stream in year *y*
GWP_{CH4} : Global warming potential of methane
$TM_{RG,h}$: Mass flow rate of methane in the residual gas in the hour *h*
$TM_{FG,h}$: Methane mass flow rate in exhaust gas averaged in a period of time
$FV_{RG,h}$: Volumetric flow rate of the residual gas in dry basis at normal conditions in hour *h*
$Fv_{CH4,RG,h}$: Volumetric fraction of methane in the residual gas on dry basis in hour *h*
$P_{CH4,n}$: Density of methane at ormal conditions (0.716 kg/m^3)
$\eta_{flare,h}$: Flare efficiency in the hour *h*

$TM_{RG,h}$ = {(3,248,024.9 Nm^3 x 51.5%) / (365 x 24)} x 54.4% x 0.716 kg/m^3
= 74.376261 kg/h

$\eta_{flare,h}$ = 90% IPCC default value for Enclosed Flare system

PE_{flare} = 74.376261 kg/h x (1 – 90%) x 21/1000 x 8,760 h/year
= 1,368.225 tCO_{2e}/year

Therefore, Total $E_{CH4\_IC + Leaks}$ for Gas Engine & Enclosed Flare
= 128.852 tCO_{2e}/year + 1,368.225 tCO_{2e}/year
= 1,497.077 tCO_{2e}/year

Total project emissions:

$E_{project}$ $= E_{CH4\_lagoons} + E_{CH4\_NAWTF} + E_{CH4\_IC+Leaks}$ (1)
= 196.504 tCO_{2e}/year + 4,688.38 tCO_{2e}/year + 1,497.077 tCO_{2e}/year
= 6,381.961 tCO_{2e}/year

Total Project Emissions for the crediting period (10 years) will be **63,819.6 tCO_{2e}/year**.

Calculation of total emissions reduction

$ER = E_{BL} - E_{project}$ (10)

where:
ER : total emission reduction (tCO_{2e})
E_{BL} : total baseline emissions (tCO_{2e})
$E_{project}$: total project emissions (tCO_{2e})

Total Emissions Reduction:
= Baseline Emissions – Project Emissions
= 30,563.15 tCO_{2e}/year – 6,381.961 tCO_{2e}/year
= 24,181.2 tCO_{2e}/year

Total Emissions Reduction for Crediting Period (10 years):
= 241,812 tCO_{2e}

The emissions of CH_4 from the lagoons in the baseline situation are not higher than the total emissions of biogas from digester and the lagoons in the project situation:

$E_{CH4\_lagoon\_BL} – (E_{CH4\ lagoon} + E_{CH4\_namtf} + E_{CH4\_coll})$ (13)

Where,
E_{CH4_coll} is the amount of CH_4 expressed in (tCO_2) contained in the biogas collected from the anaerobic treatment facility.

$E_{CH4\_lagoon\_BL}$ = 6,842.746 tCOD/year x 0.21 tCH_4/tCOD x 21 tCO_{2e}/tCH_4
= 30,176.508 tCO_{2e}/year

$E_{CH4\ lagoon}$ = 44.5587 tCOD/year x 0.21 tCH4/tCOD x 21
= 196.504 tCO_{2e}/year

E_{CH4_namtf} = 4,688.38 tCO_{2e}/year

E_{CH4_coll} = CH_4 produced in bioreactor – E_{CH4_NAWTF}
= [(50 kgCOD/m^3 x 157,500 m^3 x 0.95) – Chemical Oxidation (157,500 m^3 x 0 kg/m^3) – Deposition (50 kgCOD/m^3 x 157,500 m^3 x 0.05)]/1000 – E_{CH4_NAWTF}
= (7,481.25 tCOD/m^3 – 0 – 393.75 tCOD) – E_{CH4_NAWTF}
= (7,087.5 tCOD x 0.21 tCH_4/tCOD x 21) – E_{CH4_NAWTF}
= 31,255.875 tCO_{2e}/year – 4,688.38 tCO_{2e}/year
= 26,567.495 tCO_{2e}/year

Therefore:
$E_{CH4\_lagoon\_BL} – (E_{CH4\ lagoon} + E_{CH4\_namtf} + E_{CH4\_coll})$
= 30,176.508 tCO_{2e}/year – (196.504 tCO_{2e}/year + 4,688.38 tCO_{2e}/year + 26,567.495 tCO_{2e}/year)
= – 1,275.871 tCO_{2e}/year

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

Year	Estimation of Project activity emissions (tCO_{2e})	Estimation of baseline emission (tCO_{2e}) POME Ponds	Estimation of baseline emission (tCO_{2e}) Diesel Power	Estimation of leakage (tCO_{2e})	Estimation of emission reductions (tCO_{2e})
Nov 2007	1,066.6	5,043.2	64.6	0	4,041.2
2008	6,382.0	30,176.5	386.6	0	24,181.2
2009	6,382.0	30,176.5	386.6	0	24,181.2
2010	6,382.0	30,176.5	386.6	0	24,181.2
2011	6,382.0	30,176.5	386.6	0	24,181.2
2012	6,382.0	30,176.5	386.6	0	24,181.2
2013	6,382.0	30,176.5	386.6	0	24,181.2
2014	6,382.0	30,176.5	386.6	0	24,181.2
2015	6,382.0	30,176.5	386.6	0	24,181.2
2016	6,382.0	30,176.5	386.6	0	24,181.2
Oct 2017	5,315.4	25,133.3	322.0	0	20,140.0
Total	**63,820**	**301,765**	**3866**	**0**	**241,812**

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

The methodologies applied are designed specifically for biogas conversion, biogas recovery and electricity generation projects with the following green house gas emission reduction components:

- ►Collection, utilization or flaring of methane.
- ►Displacement of on site diesel generated electricity with biogas generated electricity.

According to the methodology, the basis for monitoring the emission reductions is the measurement of the following key parameters:

- Tonnage of palm oil fruit processed
- Wastewater volume Inlet and Outlet of bioreactor
- COD level at inlet and outlet of bioreactor
- Biogas volume and concentration
- Combustion efficiency of Gas Engine and Enclosed Flaring System
- Biogas leakages of piping line and NAWTF
- Electricity usage and generated

All data will be achieved in hard copy and soft copy for 10 + 2 years.

B.7.1 Data and parameters monitored:

Data / Parameter:	Palm oil fruit processed
Data unit:	Metric ton (t)
Description:	The amount of palm oil processed by the mill
Source of data to be used:	Mill production data
Value of data applied for the purpose of calculating expected emission reductions in section B.5	225,000 ton
Description of measurement methods and procedures to be applied:	The measurement will be based on the measurement taken by the mill at their weighbridge.
QA/QC procedures to be applied:	Annually calibration and maintenance of weighing bridge subject to appropriate industry standards. Weekly update of FFB processed based on daily weighing bridge records.
Any comment:	This data is useful to confirm our assumption that 1 ton of fresh fruit bunch processed would produce 0.7 m^3 of wastewater.

Data / Parameter:	Wastewater Flows Entering System Boundary (1)
Data unit:	cubic meter (m^3)
Description:	Volume of wastewater flows entering Bioreactor
Source of data to be used:	Measured during the project activity
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0.7 m^3 per tFFB processed
Description of measurement methods and procedures to be applied:	Flow meter and will be recorded continuously
QA/QC procedures to be applied:	Flow meters undergo maintenance/calibration subject to appropriate industry standards annually. Weekly update of flowrate of POME based on daily flow meter records.
Any comment:	This data is useful to confirm our assumption that 1 ton of FFB processed would produce 0.7 cu.m of wastewater.

Data / Parameter:	Wastewater Flows Leaving Project Treatment Facility (2)
Data unit:	cubic meter (m^3)

Description:	Volume of wastewater flows leaving Bioreactor
Source of data to be used:	Measured during the project activity
Value of data applied for the purpose of calculating expected emission reductions in section B.5	For calculating of Organic Material removal and to confirm the default value of 0.21 $kgCH_4/kgCOD$.
Description of measurement methods and procedures to be applied:	Flow meter and will be recorded continuously
QA/QC procedures to be applied:	Flow meters undergo maintenance/calibration subject to appropriate industry standards annually. Weekly update of flowrate of POME based on daily flow meter records.
Any comment:	

Data / Parameter:	Wastewater Organic Material Concentration Entering The Project Boundary (3)
Data unit:	$kgCOD/m^3$
Description:	Wastewater Organic Material Concentration Entering The Project Boundary (3)
Source of data to be used:	Measurement on site
Value of data applied for the purpose of calculating expected emission reductions in section B.5	50,000 ppm, this figure is opt quoted figure on the average COD content of palm oil mill wastewater
Description of measurement methods and procedures to be applied:	Daily measurement at bioreactor inlet point
QA/QC procedures to be applied:	COD concentration is to be measured daily using HACH spectrometer at In-house laboratory and a weekly cumulative sample will be sent to 3rd party accredited laboratory. Sampling to be carried out adhering to internationally recognized procedures and tests carried out by accredited laboratory
Any comment:	This data will be used to verify the organic load of the wastewater treatment system.

Data / Parameter:	Wastewater Organic Material Concentration Leaving The Treatment Facility (4)
Data unit:	$kgCOD/m^3$
Description:	COD concentration at bioreactor outlet
Source of data to be used:	Measured at site
Value of data applied for the purpose of calculating expected emission reductions in section B.5	2,500 ppm, this was based on an assumption that the efficiency of the bioreactor would be about 95%
Description of measurement methods and procedures to be applied:	Daily measurement at bioreactor outlet
QA/QC procedures to be applied:	COD concentration is to be measured daily using HACH spectrometer at In-house laboratory and a weekly cumulative sample will be sent to 3rd party accredited laboratory. Sampling to be carried out adhering to internationally recognized procedures and tests carried out by accredited laboratory

Any comment:	This data will be used to monitor the efficiency of the bioreactor and to estimate emissions from the remaining open lagoons.

Data / Parameter:	Electricity generated from the biogas collected in the anaerobic treatment facility & consumed on site or sent the grid (6a)
Data unit:	kWh
Description:	Measurement of electricity generated by the gas engine for Mill's usage
Source of data to be used:	Measured at site
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Average three year electricity generation by diesel generators, 644,403 kWh
Description of measurement methods and procedures to be applied:	Continuous kilowatt-hour metering at the gas engine for mill's usage
QA/QC procedures to be applied:	Electricity meters undergo normal maintenance/calibration subject to appropriate industry standards.
Any comment:	

Data / Parameter:	Electricity generated from the biogas collected in the anaerobic treatment facility & consumed on site or sent the grid (6b)
Data unit:	kWh
Description:	Measurement of electricity generated by the gas engine for project activity's consumption
Source of data to be used:	Measured at site
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Assumed that all electricity would be provided by renewable source
Description of measurement methods and procedures to be applied:	Continuous kilowatt-hour metering of electricity consumption at the project activity site
QA/QC procedures to be applied:	Electricity meters undergo normal maintenance/calibration subject to appropriate industry standards.
Any comment:	

Data / Parameter:	Electricity being consumed by Project Activity (6c)
Data unit:	kWh
Description:	Measurement of electricity being supplied by the Mill to Project Activity during breakdown / maintenance of Biogas Gas Engine
Source of data to be used:	Measured at site. 0.8 $kgCO_2$/ kWh IPCC default value will be used
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Negligible. However will monitor and include in Project Emission to reflect the actual Emission Reduction.
Description of measurement methods and procedures to be applied:	Continuous kilowatt-hour metering of electricity consumption for the project activity site
QA/QC procedures to be applied:	Electricity meters undergo normal maintenance/calibration subject to appropriate industry standards.

Any comment:	Default value for CO_2 emissions will be used although the emission coefficient should be lower than 0.8 kg CO_2/ kWh as most of the time the electricity from the mill is being generated using Biomass.

Data / Parameter:	Biogas sent to flares (8)
Data unit:	Normalized cube meter (Nm^3)
Description:	The flow rate of gas will be measured flare inlet
Source of data to be used:	Measured at site
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0.21 kg CH_4/kg COD converted
Description of measurement methods and procedures to be applied:	Continuous flow meter at flare inlet
QA/QC procedures to be applied:	Gas flow meters undergo maintenance/calibration subject to appropriate industry standards annually. Continuously update of flowrate of biogas.
Any comment:	The volume will be normalised to take pressure and temperature into account

Data / Parameter:	Biogas sent to gen sets (9)
Data unit:	Normalized cube meter (Nm^3)
Description:	The flow rate of gas will be measured Gas Engine inlet
Source of data to be used:	Measured at site
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0.21 kg CH_4/kg COD converted
Description of measurement methods and procedures to be applied:	Continuous flow meter at Gas Engine inlet
QA/QC procedures to be applied:	Gas flow meters undergo maintenance/calibration subject to appropriate industry standards annually. Continuously update of flowrate of biogas.
Any comment:	The volume will be normalised to take pressure and temperature into account

Data / Parameter:	Biogas methane (CH_4) concentration (10)
Data unit:	%
Description:	Concentration of CH_4 in the biogas
Source of data to be used:	Measured at site
Value of data applied for the purpose of calculating expected emission reductions in section B.5	CH_4 was calculated based on 0.21 kgCH_4/kgCOD.
Description of measurement methods and procedures to be applied:	Continuously measurement to satisfy statistical 95% confidence level

QA/QC procedures to be applied:	Gas Analyzer undergo annual maintenance/calibration subject to appropriate industry standards. Continuously update of Methane concentration in biogas.
Any comment:	Use to quantify the volume of methane content in the biogas as measured by the biogas flowrate

Data / Parameter:	Project emissions from flaring of the residual gas stream (11)
Data unit:	tCO_{2e}
Description:	Biogas combustion efficiency at enclosed flaring system
Source of data to be used:	Measured and calculated at site
Value of data applied for the purpose of calculating expected emission reductions in section B.5	90% IPCC default value for Enclosed Flaring
Description of measurement methods and procedures to be applied:	Continuously
QA/QC procedures to be applied:	Refer *Tool to determine project emissions from flaring gases containing Methane*
Any comment:	

Data / Parameter:	Amount of chemical oxidising agents entering system boundary (12)
Data unit:	Tonne s/m^3
Description:	Chemical Oxidising agents added during the process of crude palm oil
Source of data to be used:	Not applicable, no chemical oxidising agents added during process of crude palm oil
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Not applicable.
Description of measurement methods and procedures to be applied:	Continuously
QA/QC procedures to be applied:	Regular check with palm oil mill to identify if oxidizing agents are added during production where they are identified as being likely to be present in wastewater.
Any comment:	No oxidising agents added during the process of crude palm oil

Data / Parameter:	Gen Set combustion efficiency (13)
Data unit:	%
Description:	Biogas combustion efficiency at Gas Engine
Source of data to be used:	Measured at site
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Not applicable.
Description of measurement methods and procedures to be applied:	Annually measurement
QA/QC procedures to be applied:	Gen Set combustion efficiency will be calibrated annually.

	Efficiency rating will be determined. Combustion efficiency will be determined during regular O&M down time.
Any comment:	

Data / Parameter:	Flow of wastewater directly to the current water treatment system, and by-passing the new wastewater treatment facility (15)
Data unit:	cubic meter (m^3)
Description:	Volume of wastewater by-passing the new Bioreactor to 2^{nd} lagoon
Source of data to be used:	Measured during the project activity
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Not applicable.
Description of measurement methods and procedures to be applied:	Flow meter and will be recorded continuously when ever there is a by-pass of POME
QA/QC procedures to be applied:	Flow meters undergo maintenance/calibration subject to appropriate industry standards annually.
Any comment:	To calculate project emission during desludging of bioreactor

Data / Parameter:	Loss of biogas from pipeline (16)
Data unit:	Percentage (%)
Description:	Percentage of biogas leakage from pipeline at project boundary
Source of data to be used:	Measurements at site
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Assumed negligible.
Description of measurement methods and procedures to be applied:	Integrity of biogas pipeline for leakage of biogas will be tested annually through pressurizing the system and establishing pressure drops through leakage.
QA/QC procedures to be applied:	Annual checks to be carried out to international standards
Any comment:	

Data / Parameter:	Organic Material removed from wastewater facility (17)
Data unit:	ton COD
Description:	To measure the organic material removal in the Bioreactor system and open anaerobic lagoons system.
Source of data to be used:	Calculated through measurement at site for flowrate and COD of POME
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Not Applicable
Description of measurement methods and procedures to be applied:	Refer Parameter 1, 2, 3, 4 and 4a
QA/QC procedures to be applied:	Refer Parameter 1, 2, 3, 4 and 4a
Any comment:	To confirm default value of 0.21 $kgCH_4/kgCOD$

Data / Parameter:	Biogas Calorific Value (18)
Data unit:	J/Nm^3
Description:	Calorific value of biogas being captured at bioreactor
Source of data to be used:	Measured at site
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Not applicable
Description of measurement methods and procedures to be applied:	Annually measurement
QA/QC procedures to be applied:	Annual checks to be carried out to international standards
Any comment:	

Tool to determine project emissions from flaring gases containing Methane:

Data / Parameter:	$fv_{i,h}$ (a)
Data unit:	-
Description:	Volumetric fraction of component *i* in the residual gas in the hour *h* where *I* = CH_4, CO, CO_2, O_2, H_2, N_2
Source of data to be used:	Measurements by using a continuous gas analyser
Measurement procedures	The same basis (dry or wet) is considered in this measurement and the measurement of the volumetric flow rate of the residual gas ($FV_{RG,h}$) when the residual gas temperature exceeds 60ºC
Monitoring frequency	Continuously. Values to be averaged hourly.
QA/QC procedures to be applied:	Analysers will be periodically calibrated according to the manufacturer's recommendation. A zero check and a typical value check will be performed by comparison with a standard certified gas
Any comment:	As a simplified approach, only measure the methane content of the residual gas and consider the remaining part as N_2

Data / Parameter:	$FV_{,RG,h}$ (b)
Data unit:	m^3/h
Description:	Volumetric flow rate of the residual gas in dry basis at normal conditions in the hour *h*
Source of data to be used:	Measurements by using a flow meter
Measurement procedures	Ensure that the same basis (dry or wet) is considered for this measurement and the measurement of the volumetric fraction of all the residual gas ($fv_{i,h}$) when the residual gas temperature exceeds 60ºC
Monitoring frequency	Continuously. Values to be averaged hourly.
QA/QC procedures to be applied:	Flow meters will be periodically calibrated according to the manufacturer's recommendation.
Any comment:	

Data / Parameter:	T_{flare} (c)
Data unit:	ºC
Description:	Temperature in the exhaust gas of the flare
Source of data to be used:	Measurements at site
Measurement procedures	Measure the temperature of the exhaust gas stream in the flare by Type S thermocouple (Type S thermocouple is higher spec compared to Type N). A temperature above 500 ºC indicates that a significant amount of gases are still being burnt and that the flare is operating.
Monitoring frequency	Continuously.
QA/QC procedures to be applied:	Thermocouple will be replaced or calibrated every year. The flare has a back up thermocouple sensor in case of failure.
Any comment:	

Refer Annex 7 for Manufacturer's Operating conditions for Enclosed Flaring System. Two (2) parameters to operate Enclosed Flare System:

a) Methane concentration
b) Biogas Flowrate

B.7.2 Description of the monitoring plan:

The monitoring of the project activity will be carried out systematically as envisioned in the Monitoring Plan in Annex 4. Key personnel will be trained and assigned for the overall project management and monitoring and reporting of key parameters as required in this PDD.

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

The baseline study and monitoring methodology was completed on 04th July 2007 by:

Mohammad Iskandar Majidi Senior CDM Manager	and	Sim Kean Hong CDM Project Manager

BioX Carbon Malaysia Sdn Bhd
Level 8, Lot A, MNI Twins – Tower 2
11 Jalan Pinang
50450 Kuala Lumpur,
Malaysia

BioX Carbon Malaysia is a "project participant" as listed in Annex 1.

SECTION C. Duration of the project activity / crediting period

C.1 Duration of the project activity:

C.1.1. Starting date of the project activity:

27th October 2006

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

Technical lifetime: 12 years, 6 months (10 years in a pessimistic, 15 years in an optimistic scenario)

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

C.2.1. Renewable crediting period

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

C.2.1.2. Length of the first crediting period:

C.2.2. Fixed crediting period:

C.2.2.1. Starting date:

1st November 2007

C.2.2.2. Length:

10 years fixed crediting period

SECTION D. Environmental impacts

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

The project activity will not have any adverse environmental impacts. Furthermore the activity does not fall under those that require Environmental Impact Assessment (EIA) by the host country.

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

- Reduction of methane emission.
- Generation of green energy.
- Reduction of fossil fuel usage
- Significant reduction of odour.

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

As discussed above, the project activity will not have any adverse environmental impacts.

SECTION E. Stakeholders' comments

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

A local Stakeholders' Consultation was held to inform and gather comments on the proposed project activity. The local briefing session was organized by Tradewinds Plantation Berhad and Biox Carbon Malaysia Sdn Bhd on 6 November 2006, at Binu Palm Oil Mill. The local stakeholders were invited via advertisement in the local newspapers (Borneo Post - English and Utusan Borneo - Malay), written invitation to the statutory bodies and non-governmental organization as well as verbal invitation to local community.

The stakeholders' consultation event entails:-

- A welcoming address by the Regional Manager Tradewinds Plantation Berhad, Tuan Haji Mustafa Mohamad
- A presentation on the operation of Binu Palm Oil Mill by the mill manager, Mr Ahmad Fauzi Ismail
- A presentation on the proposed CDM project, its objectives and benefits by Mr Mohd Iskandar Majidi from Biox Carbon Malaysia Sdn Bhd
- Questions and answers session.

E.2. Summary of the comments received:

The stakeholders raised no concerns or objections during the consultation, other than some questions on the system used to capture the biogas. Generally the stakeholders were supportive of the project and its many benefits. Some of the mill managers from the surrounding mills even indicate their interest of developing similar project.

A summary of the questions and responses made by local stakeholders are included in Annex 6.

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

As stated under E.2 the stakeholders raised no major concerns or objections. The project is located at the existing wastewater site and does not require any land expansion that could affect the local community. The project activity as mentioned in the previous section will have positive effects on the local environment by improving air quality through reduction of odour and cleaner emission as well as wastewater discharge quality.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

Organization:	Tradewinds Plantations Management Sdn Bhd
Street/P.O.Box:	1 Jalan Tasik Permaisuri 2, Bandar Tun Razak
Building:	22nd Floor, Wisma Zeelan
City:	Kuala Lumpur
State/Region:	Wilayah Persekutuan
Postfix/ZIP:	56000
Country:	Malaysia
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FAX:	603-9171 9999
E-Mail:	
URL:	
Represented by:	Chan Seng Fatt
Title:	CEO
Salutation:	Mr.
Last Name:	Chan
Middle Name:	Seng
First Name:	Fatt
Department:	
Mobile:	
Direct FAX:	603-9171 7900
Direct tel:	603-9179 8888
Personal E-Mail:	chansf@twinds.com.my

Organization:	BioX Carbon Malaysia Sdn Bhd
Street/P.O.Box:	11 Jalan Pinang
Building:	Level 8 (Lot A), MNI Twins – Tower 2
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State/Region:	Wilayah Persekutuan
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Country:	Malaysia
Telephone:	603-2163 6299
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E-Mail:	info@biox.nl
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Represented by:	Mohammad Iskandar Majidi
Title:	Senior CDM Manager
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Organization:	BioX Carbon BV
Street/P.O.Box:	P.O. Box 346
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State/Region:	
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Country:	The Netherlands
Telephone:	31113-689 150
FAX:	31113-689 155
E-Mail:	info@biox.nl
URL:	www.biox.nl
Represented by:	Ard van de Kreeke
Title:	Managing Director
Salutation:	Mr.
Last Name:	Kreeke
Middle Name:	Van de
First Name:	Ard
Department:	
Mobile:	
Direct FAX:	31113-689 155
Direct tel:	31113-689 150
Personal E-Mail:	Ard.vandeKreeke@biox.nl

Annex 2

INFORMATION REGARDING PUBLIC FUNDING

No public funding for this project.

Annex 3

BASELINE INFORMATION

Project Description			
Short description of project:		Methane gas capture & power generation	
Crediting time:	years	10	
Power Generation Technology		Gas engine generator	
Installed capacity:	MWel	0.3	
Project Costs			
Investment costs:	RM	2,535,000	
Average annual project operation costs:	RM	450,000	
Parameters		**Value**	**Source**
Biogas generation potential	$kgCH_4/kgCOD$	0.21	IPCC
Raw effluent COD	ppm	50000	Published studies
GWP of methane: GWP_ CH_4	tCO_2/tCH_4	21	UNFCC
Emission factor: $CEF_{electricity}$	$kgCO_{2e}/kWh$	0.8	IPCC (Diesel)
Baseline			
Short description of baseline:		Unimpeded release of methane to the atmosphere from open lagoons	
Fresh fruit bunch processed	t/yr	225,000	
Palm oil effluent treated	m^3/yr	157,500	
Diesel consumption for power generation	ltr/yr	246,588	
Electricity consumption (average 3 years)	kWh/yr	644,403	

Output				
GHG Emissions (estimates)		Baseline	Project	ER
1st crediting period (years 2007-2016):	tCO_{2e}	305,631	63,820	241,812

Annex 4

MONITORING INFORMATION

MONITORING PLAN

1. Introduction

The purpose of this Monitoring Plan (MP) is to provide a standard operating procedure by which monitoring and verification activity can be conducted on the Project activity. The MP shall be in accordance with all relevant rules and regulations of the CDM. The MP is an integral part of this PDD and can be utilized to facilitate accurate and consistent monitoring of the Project's Certified Emission Reductions (CERs).

The MP will be followed for the duration of the Project activity. The company will strictly follow the MP in order to measure and track the project impacts and prepare for the periodic verification process required to confirm the amount of CERs achieved.

Specifically, the MP facilitates the following;
- Establishing and maintaining a suitable monitoring system
- Guide for the implementation of necessary measurement and management operations
- Guide for meeting CDM requirements for verification and certification

2. Operational and Monitoring Obligations

In order to facilitate accurate CER determination, the project participant must fulfill a number of operational and data collection obligations. This will ensure that CERs are calculated in a transparent manner and monitoring is carried out as stipulated in the MP.

All data required for baseline and emission reduction determination shall be monitored as directed in this PDD.

3. Management and Operational Systems

In order to ensure a successful operation of the Project and the credibility and verifiability of the CERs achieved, the Project will have a well-defined management and operational system. A system will be put in place for the Project and include the operation and management of the monitoring and record keeping system that is described in this MP.

3.1 Allocation of Project management responsibilities

The management and operation of the Project is the responsibility the Project operator. Ensuring the environmental credibility of the Project through accurate and systematic monitoring of the project's implementation and operation for the purpose of achieving trustworthy CERs is the key responsibility and accountability of the operator.

3.2 Management and operational systems

The project developers will implement a management and operational system that meets the requirements of the Project. This includes:

3.2.1 Data handling

- The establishment of a transparent system for the collection, computation and storage of data, including adequate record keeping and data monitoring systems. The project participants will develop and implement a protocol that provides for these critical functions and processes, which will be fit for independent auditing.

3.2.2 Quality assurance

- A competent manager will be appointed who will be in charge of and accountable for the generation of CERs including monitoring, record keeping, computation of ERs, audits and verification. The person will officially sign-off on all GHG Emission worksheets.
- Well-defined protocols and routine procedures, with good, professional data entry, extraction and reporting will be encouraged to maximise transparency of data archiving.
- Proper management processes and recording of official data

3.2.3 Training

- Internal training will be made available to operational staff to enable them to undertake the tasks required by this MP. Initial staff training will be provided before the Project starts operating and generating CERs.

Annex 5:
Malaysia National CDM Criteria

National CDM Criteria

This Table describes how the project satisfies the Malaysian National CDM Criteria:

The project must support the sustainable development policies of Malaysia and bring direct benefits towards achieving sustainable development;	The proposed project addressed the sustainability of palm oil industry by improving the CO2 neutrality of the supply chain. This would be advantages to the palm oil industry in particular and Malaysia as a whole as more consumers is demanding for sustainable food production. The propose project is in support of the government efforts in developing and promoting the utilisation of renewable energy resources. Increased utilisation of renewable energy resources is strategically important in the long term as it will contribute to the sustainability of energy supply.
Implementation of CDM projects must involve participation of Annex 1 Party/Parties;	The project is jointly developed by Tradewinds Plantations Management Sdn Bhd and BioX Carbon Malaysia Sdn Bhd. The Annex 1 party involve in the project is BioX Carbon BV of Holland.
Project must provide technology transfer and/or improvement in technology;	BioX Carbon will provide the technology and expertise on biogas capture and gas engine system. The proposed system would utilise the latest biotechnology in optimising biodegradation of wastewater COD and cleaning of the biogas. The project would also be equipped with the latest biogas monitoring and flaring system.
Project must fulfill all conditions underlined by the CDM Executive Board;	The project activity would be developed according to the CDM Approved Methodology AM0022 and would follow and fulfil all conditions and procedure there in.
Project proponent should justify the ability to implement the proposed CDM project activity	Both Tradewinds Plantations Management and BioX Carbon Malaysia would jointly contribute to the cost of implementing the project activity with technological support from BioX BV.
Giving due importance to environmental considerations	The project will reduce the emission of green house gas from the palm oil mill particularly methane from wastewater treatment ponds. The captured methane would be combusted to produce clean renewable power using state of the art gas engine technology, which will lead to less environmental impact. The project will be implemented to comply with all applicable environmental regulations in the country.

Annex 6:
Stakeholder Consultation

Participants attended the Stakeholders' Consultation:-

No	Names	Company
1.	Mr Mohamad Izali B. Majid	Ladang Sungai Kelad
2.	Mr William Bala	Sekolah Kebangsaan Beluru (School)
3.	Mr Yong Hua Kong	TEK (M) Sdn Bhd
4.	Mr David Ong	TEK (M) Sdn Bhd
5.	Mr Lin Chua Yau	TEK (M) Sdn Bhd
6.	Mr Trang Ong Chuong	Sarawak Oil Palm Berhad
7.	Mr Kin Kwong Chiang	Sarawak Oil Palm Berhad
8.	Mr Awang Mohammad Ang Sahda	District Office Bakong
9.	Penghulu Saidi	District Office Bekenu
10.	Mr Chai Ko Hiet	Miri City Council
11.	Mr Azerun Alias	Sekolah Menengah Kebangsaan Bakong (School)
12.	Ms Norina Frederick Sambang	Department of Environment Miri
13	Mr Rosdi Mawi	Department of Environment Miri
14.	Mr Mohd Zaihan Hj Lek	Department of Environment Kuching
15.	Mr Chin Ming Foo	Chin Mee Hwa Construction Sdn Bhd
16.	Mr Lam Kah Kuan	RHP Oil Mill
17.	Mr Lee Chi Hong	Kina Juara Sdn Bhd
18.	Mr Kenny Poon	Natural Resource and Environmental Board
19.	Mr Sati Bandat	Natural Resource and Environmental Board
20.	Mr Kennedy ak Nujong	Natural Resource and Environmental Board
21.	Mr Sardon Zainal	Kawan Dynamic Engineering
22.	Mr Alias Johari	Malaysia Palm Oil Board
23.	Mr Zainal Osman	Malaysia Palm Oil Board
24.	Mr Mohaini Sarbol	Malaysia Palm Oil Board
25.	Mr Lee Kim Lee	Sekolah Jenis Kebangsaan Hua Kwong (School)
26.	Mr Tai Teck Shin	Palmplus Technology
27.	Mr Hamdani Hasfa	Sarawak Plantation Berhad
28.	Mr Mergi Joshua	Sarawak Plantation Berhad
29.	Mr R Raja	Binu Palm Oil Mill Settler
30	Mr Razali	DE BAO Engineering
31.	Tuan Haji Mustafa Mohamad	Tradewinds Plantation Berhad
32.	Mr Choong Siew Ming	Tradewinds Plantation Berhad (Mills)
33.	Mr Asmal Ab Hadi	Tradewinds Plantation Berhad (Miri)
34.	Ms Christina Wong	Biox Carbon Malaysia Sdn Bhd
35.	Mr Mohd Iskandar Majidi	Biox Carbon Malaysia Sdn Bhd

Questions raised and answered during the Stakeholders' Consultation:-

Question	Answer
1. Kindly show the project drawing again presented during the CDM project presentation. During the second phase of the project i.e. installation of the gas engine for converting biogas to energy, what is the basis for gas captured calculation? By: Mr Mohd Zaihan Hj Lek – DOE Kuching	Binu Mill is Biox Carbon's Pilot Project therefore the raw data are from previous years' data and the calculation is an estimation based on the approved UNFCCC methodology formula.
2. How many projects have been set up in Malaysia with the similar project details? By: Mr Chai Ko Hiet – Miri City Council	A biogas power generation project was done by Sime at Tanamaran Mill in the 1980s but the project was discontinued due to the high cost of maintenance of the gas engine. Another biogas utilisation project has been implemented by Keck Seng using anaerobic tanks and the gas is piped for combustion in boiler. This project has successfully been implemented as the mill is located adjacent to a refinery which has higher energy demand.
3. What is the ROI (Return of Investment) for a project like this? By: Mr Chai Ko Hiet – Miri City Council	Without benefit from CDM, this project will not be viable. However with carbon credit obtained under CDM the project would have an IRR of 36% based on CER of €10.
4. Can the gas captured be distributed to the houses of the surrounding community for cooking? By: Mr Awang Mohammad Awg Sahda – District Office Bakong	Yes but due to numerous risks involve, Biox would not recommend this at this stage.
5. Any impact on the sludge oil that is to be disposed for this kind of projects? If the sludge oil goes into the anaerobic pond, will it impact the project? By: Mr Alias Johari – Malaysia Palm Oil Board	No, if the sludge oil is high in the anaerobic pond, more biogas could be released.
6. How is the gas harvesting procedure, will it be able to separate the methane from other gases? Will the methane purification have any impact on the output of the gas engine that converts the methane into	Biox's system will cover-up one of the anaerobic ponds to capture the biogas. Methane will not be separated from other gas in the system. The biogas will be cleaned (scrubbed) before usage. The system will have a flow meter to monitor the amount of

	renewable energy? By: Ms Norina Frederick Sambang – DOE Miri	biogas captured and composition of methane in the biogas. Scrubbing of the biogas is essential to the continuous operation of gas engine. The output of the gas engine will not be affected if the methane content of the biogas range between the expected 55% to 65%.
7.	If the temperature changes, what is the effect on the covered anaerobic pond and the biogas? What is the lifespan of the tarpaulin for the bioreactor and what is the impact on the de-silting of the pond? By: Mr Zainal Osman – Malaysia Palm Oil Board	The temperature and pH under the covered pond will be continuously monitored and controlled in order to ensure perfect condition for the anaerobic bacteria to propagate and continuously produce biogas. The changes in ambient temperature are expected to have minimum effect on the covered pond. The tarpaulin has a lifespan of 5-8 years. As the covered pond is equipped with an agitation mixing system using biogas, silting problem is expected to be eliminated and if at all required de-silting work would be time together with the tarpaulin cover change.
8.	What is the calculation used for diesel savings mentioned during the presentation? By: Ms Norina Frederick Sambang – DOE Miri	The raw data used for the calculation on diesel savings is based on baseline figures recorded during the past three years. In our calculation we assumed that diesel saving would be about 75% of annual consumption from reduction in running hours of existing diesel generators.

Comments received during the PDD was made publicly available on DNV's climate change website (www.dnv.com/certification/climatechange):-

Comment		Answer
1.	Re: page 2, Section B.2 – According to the Applicability Criteria no. 2 of AM0022, the organic wastewater contains simple organic compounds (mono-saccharides). Obviously, palm oil mill effluent from palm oil processing (more of triglycerides and fatty acids), which is drastically different in characteristics from wastewater of the starch industry, does not meet this requirement. Instead, the approved methodology which has been developed for palm oil mill effluent should be applied.	In POME, oil content contribute only 0.6 – 0.7% (6,000 – 7,000 ppm) and 4 – 5% total solids including 2 – 4% suspended solids[12]. The main carbon components of the POME are oil, glucose and xylose[1]. In AM0022, the methodology allow to be applied for wastewater not akin to simple sugars such as the starch industry, but appropriate CH_4 emission factor different from 0.21 $kgCH_4/kgCOD$ has to be applied. In this case, based on the study by Yacob *et al.,* 2006, an average of 0.238 $kgCH_4/kgCOD$ was emitted from anaerobic pond treatment of POME[2] so the use of 0.21 $kgCH_4/kgCOD$ is assume to be acceptable.

2. Re: Section B.6.3 – It was stated in the Project Assumption for the Project Emission calculation on page 22 that: "The average treatment efficiency of anaerobic lagoons is 50% (based on anaerobic lagoon treatment efficiency in baseline scenario)". The factor of 0.5 should be applied to the calculation of the term M/lagoon_total/ not only for the project emissions but also for the baseline emissions case. By: Chan Yik Kew – University of Malaya	The 70% used for Project Emission is based on the COD removal efficiency from Inlet of 2nd Pond till final discharge at 6th anaerobic pond. While in Baseline Emission calculation, 95% is used because it is the removal efficiency from Inlet of 1st Anaerobic pond till final discharge of 6th Anaerobic pond. According to the study done by Yacob *et al.*, 2006, COD removal rate in anaerobic ponding is 97.8%[2].

Invitation to Non-Governmental Organizations and response

NGOs	Feedback / Question	Answer
1. Centre for Environment, Technology & Development Malaysia (CETDEM) – Mr Gurmit Singh	(Pending)	
2. Traffic Southeast Asia, Regional Office – Mr Chen Hin Keong	Thank you for your invitation to the stakeholders' comments. The issue is outside of my area of expertise but I would like to thank you for the invitation in any case. I wish you all the best and hope you will have a successful meeting	N/A
3. World Wildlife Fund Malaysia – Ms Sujatha Krishnan	Thank you so much for your invitation to this event. I have passed this on to my colleague, Darrel Webber, who is the best point of reference for this, but unfortunately he would not be able to attend as Darrel has prior engagements. For your information, WWF as an organization supports and recognizes best practice methodologies for project development that delivers high quality carbon credits of premium value as prescribed by The Gold Standard. For more information please go to	N/A

	http://www.cdmgoldstandard.org/index.php . Compliance with The Gold Standards would meet with no objections nor comments from WWF-Malaysia.	
4. World Wildlife Fund Malaysia for Forest Conversion Initiative Programme – Mr Darrel Webber	(Replied as per above)	N/A
5. Borneo Resources Institue Malaysia (BRIMAS) – Mr Raymond Apin	(No respond)	N/A

Pictures taken during the Stakeholders' Consultation:-

Signage to Welcome Participants

Participants' Registration

Welcome speech by Tuan Haji Mustafa

Local Stakeholders enjoying the presentation

CDM project presentation by Mr Mohd Iskandar Majidi

Local Stakeholders concentrating during Q&A session

Annex 7:
Manufacturer's specification of Enclosed Flaring System:

Operating Conditions:

Component	Symbol	Volume Fraction (min)	Volume Fraction (max)
Methane concentration	CH_4	40%	65%

Gas Flow Rate at Different Methane Concentration:

Methane Concentration	40%	65%
Maximum Gas Flow Rate (Nm^3/hr)	1,121	695

Annex 8:
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