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:

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Inno-Abedon - Palm Oil Mill Waste Recycle Scheme, Malaysia
Version number: 1.0
Date: December 19th 2007

A.2. Description of the project activity:

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Project background

The growth of the palm oil industry in Malaysia has been phenomenal over the last 50 years. From merely 54,000 hectares in 1960 to 4 million hectares in 2005, when over 70 million tonnes of fresh fruit bunches ("FFB") were processed and 15 million tonnes of crude palm oil ("CPO") produced. The process of extracting CPO in the palm oil mills ("POM") produces a large amount of wastes predominately in the form of empty fruit bunches ("EFB") – 23% of FFB, palm oil mills effluents ("POME") – 0.70m^3 per tonne FFB and decanter sludge – approximately 3% of FFB. As a result of the remote locations of palm oil mills in general, these wastes, especially POME, which has an extremely high content of degradable organic matter, may have adverse pollution impact in the event that they are not treated properly. There are also the environmental implications and typical environmental problems associated with plantation agriculture ie. soil erosion and water pollution due to application of chemical fertilisers and pesticides.

Objective of the project activity

The objective of the project is to provide a total waste treatment solution for the Abedon Oil Mill Sdn Bhd ("Abedon") palm oil mill located near Sandakan in the state of Sabah, Malaysia, whereby the project activity will build, operate and own a waste treatment plant next to the palm oil mill. The project activity will:

1) use the bioorganic solid waste EFB(100%), decanter sludge (100%) and 60% of the pre-treated (as described in point 2) organic wastewater POME via an In-Vessel co-composting facility integrated with a special bio-formulation technology, to turn these waste into bio-organic fertiliser that will be utilized on the plantations that supply the mill with FFB. This bio-organic fertilizer has a commercial market in the palm oil plantations, fruits and vegetables farms in Malaysia and the region;
2) pre-treat 100% of organic wastewater POME using a suspended solids removal treatment to eliminate the solid particles and reduce the Chemical Oxygen Demand ("COD") content before application to the co-composting process. The sludge resulting from this pre-treatment process will be added to bio-organic solid waste mix. The remaining 40% of the pre-treated POME will pass through an aerobic pond system to achieve a final discharge with a BOD and COD level meeting the regulatory requirement.

The key by-product of this waste treatment process is the identified blends of bio-organic fertiliser that will be sold and used by the surrounding palm oil estates, thus providing a full recycle of the waste resources back to the plantations that produce the FFB.

Greenhouse gas mitigation potential

Due to the prevailing practices and associated high cost of transportation (in remote locations), the EFB bio-mass is commonly piled up in the vicinity of the palm oil mills or on landfill sites on the mill plantation and left to decay, which leads to uncontrolled methane emission and putrid odours. Common practice is also to treat POME in deep anaerobic lagoons before discharge, releasing a further large quantity of methane into the atmosphere in an uncontrolled manner.

The project activity will reduce greenhouse gas emissions by reducing methane emissions from the rotting EFB waste piles and anaerobic POME treatment lagoons.

Sustainable development contribution of the project activity
The project will contribute to sustainable development in the Malaysia Palm Oil Industry through:

(1) Comprehensive recycling of palm oil process waste. The project activities encourage the effective use of bio-technology to deal with the large amount of agricultural/green waste from the palm oil process for the production of bio-organic fertilisers that will be recycled back to the plantations.
(2) Due to the efficacy of these bio-organic fertilisers, this recycle process will enable a significant reduction in the use of chemical fertilisers by the plantations. This reduction in chemical fertilisers' usage will reduce the amount of these to be transported into these remote locations. Malaysia imports most of its chemical fertilisers. The use of these bio-organic fertilisers will also improve the soil conditions and plant health.
(3) Bio-organic fertilizers reduce chemical fertilizer run off that is causing extensive problems in rivers and estuaries in Sabah and the Malaysian peninsula.

Environmental benefits and sustainable rural development
This project is in line with the Malaysian Government's direction in the 9th Malaysian Plan published in 2006, in which the government encourages privately led sustainable development in agro-based industry and bio-technology through environmentally friendly waste treatment and recycling. Chapter 22 of the 9th Malaysian Plan states that: "Greater focus will be placed on preventive measures to mitigate negative environmental effects at source, intensifying conservation efforts and sustainable management of natural resources. Emphasis will be given to the fostering of closer cooperation between stakeholders in addressing environmental concerns."

The availability of a consistent supply of single-sourced uncontaminated bio-organic fertilisers will also contribute to the sustainable development in the agricultural sector especially in the production of greener/organic food crops in palm oil plantations and in local rural communities. The project activity also provides additional employment opportunities for local communities.

A.3. Project participants:

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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)	Inno Integrasi Sdn Bhd (Private Entity)	No
UK	Climate Change Capital Carbon Fund II S.à r.l (Private Entity)	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:

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Abedon Palm Oil Mill

A.4.1.1. Host Party(ies):

>>
Malaysia

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

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State of Sabah, Malaysia

A.4.1.3. City/Town/Community etc:

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Near the town of Sandakan, Sabah

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

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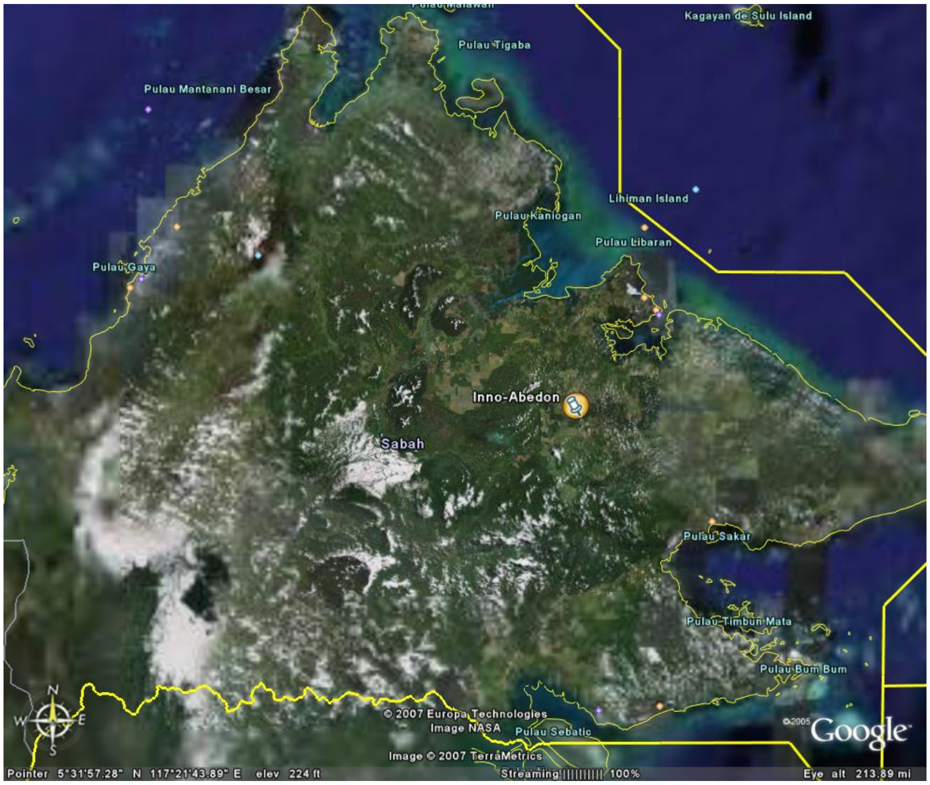
The waste treatment plant is located on-site, next to a palm oil mill owned and operated by Abedon Oil Mill Sdn Bhd (“Abedon”) at Kawasan Kg Paris, KM122 Sandakan-Lahad Datu Highway, Kinabatangan, Sabah.



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

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The category of the project activity is: 13 – Waste Handling and Disposal

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

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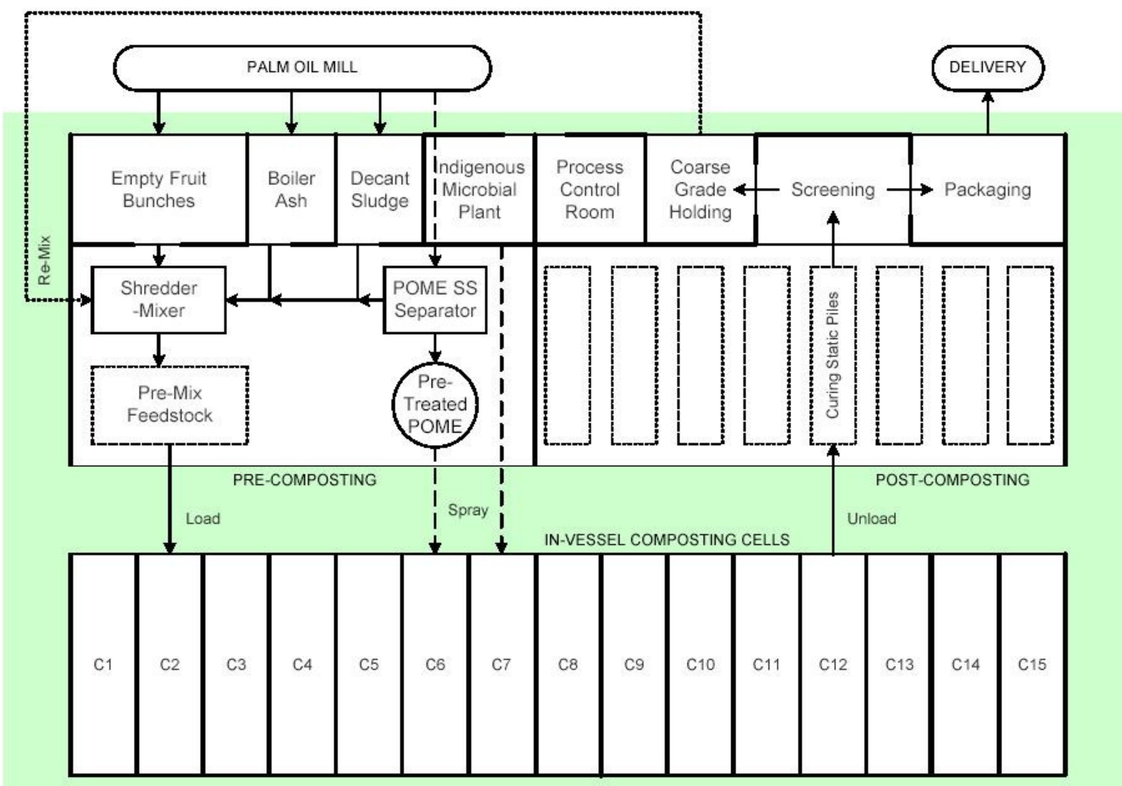
The two main technologies employed by the project activity, 1) In-Vessel biomass composting and 2) waste water pre-treatment using a suspended solids separator, are proven technologies, and are known to be environmentally friendly and safe. However, the deployment of these technologies in the palm oil industry is still in its early stages. The project developers intend to combine these processes into an integrated technology for one-stop treatment on palm oil process wastes.

The project activity will involve the construction and operation of a waste treatment plant next to the existing Abedon palm oil mill, thereby reducing transport costs for the waste materials used in the treatment process. The waste treatment plant will consist of a pre-composting section, in-vessel composting, and post-composting sections with a total covered area of approximately 0.8 hectares. The plant layout is shown in the following figure.



Waste water treatment process
All of the raw POME discharge from the palm oil mill will be pre-treated via suspended solids separators. This process will separate suspended solids in POME to capture nutrient solids to feed into composting pre-mix and substantially reduce the BOD/COD of the pre-treated POME. The pre-treated POME will be injected into composting vessel in the automated process to maintain constant moisture content in the composting feedstock. As the In-Vessel composting process consumes some 60% of the

pre-treated POME, the remaining 40% of de-sludged POME will be treated in aerobic lagoons and/or recycled back to the estate as irrigation water. In the aerobic lagoons or in land application the bulk of the remaining BOD/COD in the POME is converted to CO_2 without the formation of methane. The treatment plant process and follow up aerobic treatment of some 40% of the pre-treated POME essentially treats all of the POME effluent (including the decanter sludge – a first stage pre-treatment of the POME) under aerobic conditions.

In-Vessel biomass composting

The waste EFBs from the palm oil mill will be shredded to a predetermined size in the pre-composting section and then mixed with sludge (from both decanter and suspended solids removal treatment) and boiler ash. The resulting biomass mixture will then be transferred by front end loader into the In-Vessel composting tunnels and piled into heaps of approx 2 m height along the full width (6 m) and length (25 m) of the tunnels. Once filled the tunnel will be sealed off and the air blowers started under computer control to ensure optimum composting process conditions according to a pre-determined batch processing temperature schedule. The composting process is activated using a mixture of specially formulated microorganisms mixed with the pre-treated POME and sprayed on to the composting heap. The computer managed control system will enable completion of the composting process in the vessel in 2 to 4 weeks by careful control of oxygen levels in the biomass as well as the temperature and moisture levels. At the high temperatures in the process large quantities of POME are sprayed onto the composting waste and evaporated, thereby maintaining the optimum moisture levels. After 2 to 4 weeks the composted waste will be removed by a front end loader from the vessel and matured in piles for a further 7 days to allow the curing process to continue and temperature to reduce by natural cooling.

Feed Stock preparation

In-Vessel co-composting

Curing

After the maturation period the composted waste is mixed with special bio-formulations and then bagged for distribution to the plantation or other end users. The process will utilise 100% of the EFB, 100% of sludges (from decanter and suspended solids removal treatment) and 60% of the pre-treated POME. The In-Vessel co-composting process flow diagram is shown below.

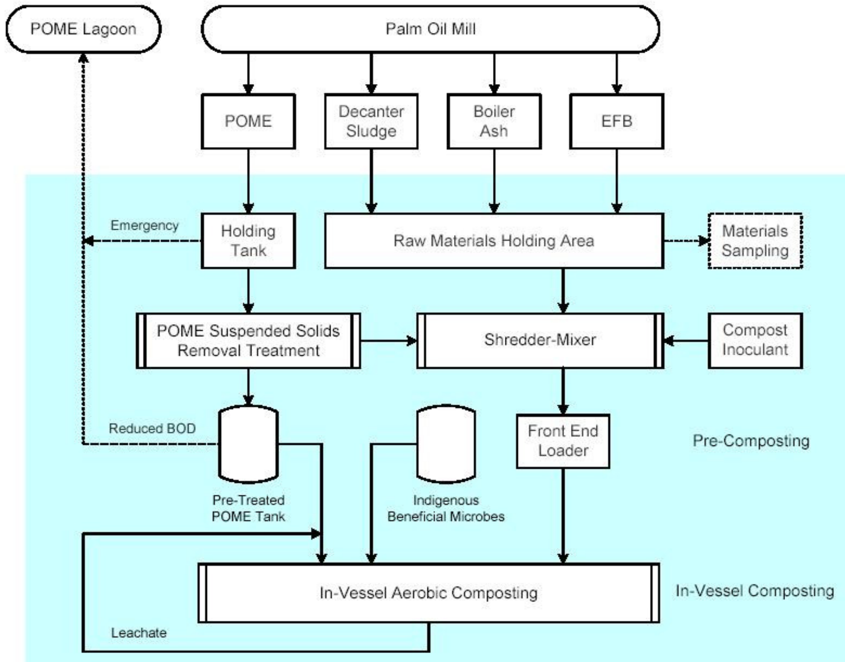


Diagram 1 : In-Vessel co-composting process flow diagram

Operation and maintenance training requirements
The project activity will require both high skilled and medium/low skilled work force in order to operate the proposed technology and maintain the facilities and installations.
While a majority of the less skilled workers is expected to be outsourced from the existing staff operating the palm oil mill, these workers will receive specific training including training on the following matters:
- Purpose of the project and objective of the project activities
- General description of the operation of the composting facility
- Operation and maintenance of individual equipment and mechanical elements
- Quality control and quality assurance procedures
- Recording of performance metrics
- Health and security issues

More skilled workers will be selected among the trained resources available in the country. It is expected that the technical staff will be a combination of mechanical engineers and biologists. Mechanical engineers will manage on site operations as well as ensure the quality of the operation and final product. The bio-technology experts will be in charge of supervising the application of the bio-formulations to ensure the maximum benefits. The project participants intend to retain qualified and experienced personnel that are ready to start operations soon after the project implementation. While training requirements will be reduced it is expected that project specific information sessions as well as training from equipment manufacturers will be required. Time and ad hoc training will be provided to all staff members to ensure the optimal ability in the operation of the different segments that form the project activities.
Consultants to the project, as well as servicing contracts from vendors and equipment manufacturers will be arranged to ensure the optimal operation of the plant and to maximize the reliability of operations to achieve up to a 95% plant availability during the crediting period.
Personnel, training and maintenance provisions have been made for the duration of the project and have been included in the viability analysis of the project

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

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The total emission reductions of the project activities over the first crediting period of 10 years are expected to be 385,982 tonnes CO_2e.

Years	Annual estimation of emission reductions in tonnes of CO_2e
Year 1: 10/2008 – 09/2009	20,733
Year 2: 10/2009 – 09/2010	25,079
Year 3: 10/2010 – 09/2011	29,275
Year 4: 10/2011 – 09/2012	33,327
Year 5: 10/2012 – 09/2013	37,239
Year 6: 10/2013 – 09/2014	41,017
Year 7: 10/2014 – 09/2015	44,665
Year 8: 10/2015 – 09/2016	48,187
Year 9: 10/2016 – 09/2017	51,588
Year 10: 10/2017 – 09/2018	54,873
Total	385,982
Total number of crediting years	**10 years**
Annual average over the crediting period of estimated reductions (tonnes of CO_2e)	38,598

A.4.5. Public funding of the project activity:

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No public funding is involved in these project activities

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:

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The approved baseline and monitoring methodology AM0039, version 2, "Methane emissions reduction from organic waste water and bioorganic solid waste using co-composting" is applied to this project activity.

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

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AM0039
This methodology is applicable as the project activities will avoid methane emissions that would have occurred in the current scheme of operations, from

- anaerobic degradation of the organic wastewater (POME) in open lagoons or storage tanks; and
- natural decay of bioorganic solid waste (EFB) in landfills.

Applicability criteria of AM0039	Project Activity
Organic wastewater and bioorganic solid waste can be generated at separate locations;	The organic wastewater (POME) and bioorganic solid waste (EFB, sludge, and boiler ash) are generated at the individual palm oil mill. The project activity will treat all these waste streams.
The bioorganic solid waste can be of a single type or multiple types mixed in different proportions. The proportions and characteristics of different types of bioorganic waste processed in the project activity can be determined, in order to apply a multiphase landfill gas generation model to estimate the quantity of landfill gas that would have been generated in the absence of the project activity;	The bioorganic solid waste component used in the calculation of the baseline is EFB. EFB is weighed before entering the composting plant for billing purposes. The project has performed tests on the physical and chemical characteristics of the EFB.
Project activities shall employ co-composting process for treatment of the organic wastewater and the bioorganic waste;	The project activities employ co-composting process for 100% of the EFB, 100% of POME sludges and 60% of the pre-treated POME output from the palm oil mill

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

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The project boundary includes all GHG emission sources from anaerobic process including open lagoons or storage tanks treating organic wastewater, the landfill site where the bioorganic solid waste would be disposed of in the absence of project activity, the proposed aerobic process, transportation and auxiliary equipment.

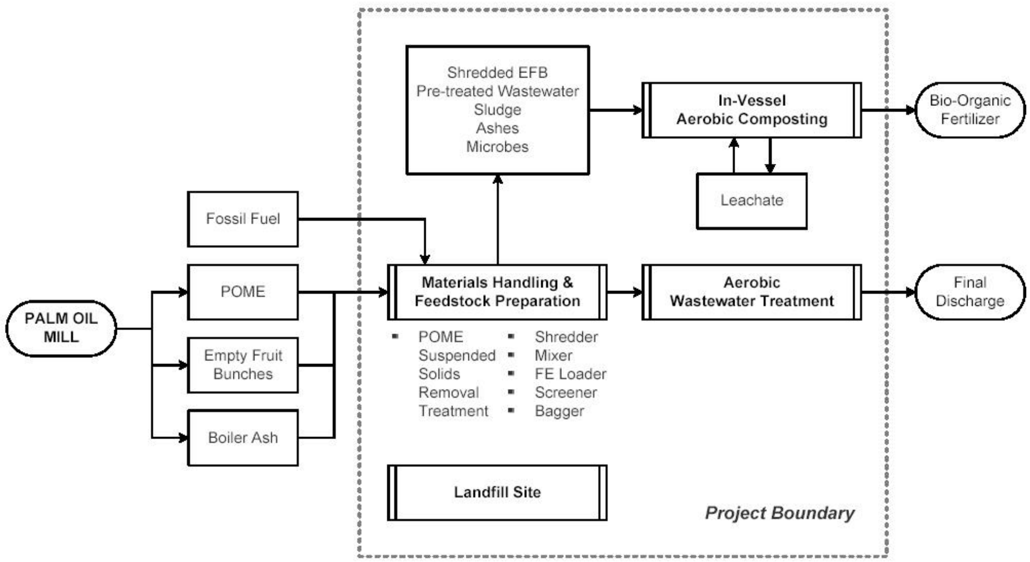

Table 1: Summary of gases and sources included in the project boundary,

	Source	Gas	Included?	Justification / Explanation
Baseline	Biomass disposed in landfills	CO_2	No	CO_2 emissions from biomass decay in landfills is considered GHG neutral.
		CH_4	Yes	Methane emission from biomass decay in the landfills
		N_2O	No	Not significant. Excluded for simplification and conservativeness.
	Open Lagoons	CO_2	No	CO_2 emissions from biomass source are considered GHG neutral.
		CH_4	Yes	Methane emission from anaerobic process
		N_2O	No	Not significant. Excluded for simplification and conservativeness.
	Transportation	CO_2	No	Emission from combustion of fossil fuel in transport vehicles. Not significant. Excluded for simplification and conservativeness
		CH_4	No	Not significant. Excluded for simplification and conservativeness
		N_2O	No	Not significant. Excluded for simplification and conservativeness
	Auxiliary	CO_2	No	Baseline includes the use of renewable energy sources (biomass) for electricity production

		CH_4	No	Not significant. Excluded for simplification and conservativeness
		N_2O	No	Not significant. Excluded for simplification and conservativeness

	Source	Gas	Included?	Justification / Explanation
Project Activities	Composting process	CO_2	No	CO_2 emissions from composting process are considered GHG neutral.
		CH_4	Yes	Methane emissions from anaerobic pockets during composting process
		N_2O	Yes	N_2O emissions from loss of N_2O-N during composting process and during application of the compost
	Leaked Waste Water	CO_2	No	CO_2 emission from biomass source and considered GHG neutral.
		CH_4	No	There is no methane emission from anaerobic process of wastewater collected after the project activity as all the water is pre-treated and managed aerobically or used for irrigation
		N_2O	No	Not significant, excluded for simplification
	Additional Transportation due to Project Activity	CO_2	No	Emission from combustion of fossil fuel in transport vehicles. Not significant, excluded for simplification
		CH_4	No	Not significant, excluded for simplification
		N_2O	No	Not significant, excluded for simplification
	Auxiliary Equipment	CO_2	Yes	Emissions from fossil fuels used in the compost manufacturing process
		CH_4	No	Not significant, excluded for simplification
		N_2O	No	Not significant, excluded for simplification

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

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As indicated in the combined tool to demonstrate the baseline scenarios and demonstrate additionality the most plausible baseline scenario shall be determined for both, organic wastewater and bioorganic solid waste, separately.

Step 1: Listing a range of potential baseline options

Step 1.a. For bio-organic solid waste:

1) Waste used for co-composting (the project activity implemented without CDM);
2) Uncontrolled open burning
3) Waste returned to the plantation for mulching
4) Waste incinerated in controlled conditions or used for energy purposes including power generation
5) Continuation of waste disposed on a landfill without the capture of landfill gas;

6) Waste disposed on a landfill where landfill gas is captured and flared;
7) Waste disposed on a landfill where landfill gas is captured and electricity generated;
8) Waste disposed on a landfill where landfill gas is captured and delivered to nearby industries for heat generation.

For organic wastewater:

1) Continuation of current practice of using anaerobic lagoons or open storage tanks without methane recovery and flaring;
2) Wastewater used for co-composting (the project activity implemented without CDM);
3) Anaerobic lagoons or storage tanks with methane recovery and flaring;
4) Anaerobic lagoons or storage tanks with methane recovery and utilization for electricity or heat
5) generation;
6) Building of a new anaerobic lagoon or open storage tanks without methane recovery and flaring;
7) Building of a new anaerobic lagoon or open storage tanks with methane recovery and flaring;
8) Direct release of waste to nearby waterways
9) Aerobic treatment facilities

Step 1.b: Eliminate alternatives that are not complying with applicable laws and regulations

For bio-organic solid waste, the uncontrolled open burning is illegal and not permitted; hence this scenario will not be taken into consideration throughout this analysis.
For organic waste water, the direct release of waste water to nearby water way is illegal and not permitted; hence this scenario will not be taken into consideration in the following analysis.

Step 2: Barrier Analysis

Step 2.a.&b. Eliminate alternatives that face prohibitive barriers

Scenarios that face prohibitive barriers will be eliminated by applying step 2 of the latest version of the "combined tool to demonstrate the baseline scenarios and demonstrate additionality" agreed by the CDM Executive Board. The main types of barriers for project implementation can be classified as technical, financial, social and business culture. 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.

For bio-organic solid waste

Waste used for co-composting (the project activity implemented without CDM);
Without CDM support this is not a plausible alternative, due to business culture, financial and technical barriers.

As palm oil mills are profitable, especially with current high palm oil prices, and dispose of all waste in line with industry and environmental regulations, there is consequently limited incentive to change business practice.

Moreover, this is an early deployment of this technology in Malaysia in the Palm Oil industry. While the individual technologies that will be used in the process are proven in other applications, the joint application to treat these waste streams has yet to be accepted by the palm oil industry. It will provide an opportunity for future technology transfer within the industry and consequently will bring exposure to all

the technology and financial risks that are associated with being the early adopter of a new technology application. To develop the project without the assistance of CDM finance, mill owners would have to risk their own investment capital, increase operating costs, significantly reduce medium term profitability and change business practices, without a driving business need.
CDM was developed with just such projects in mind, whereby CDM finance reduces the risk of introducing and applying new low carbon emission technologies until the penetration achieves a critical mass in the industry that changes the prevailing business practice.

Waste returned to the plantation for mulching
The Abedon plantations do not use EFBs for mulching, as it has limited fertilizer value, can remove nitrogen from the soil and the cost of application/distribution into the estate is relatively high as the volume to be mulched and distributed on a daily basis is substantial. It can also spread plant diseases which is a constant source of concern for all palm oil growers. Financial barriers and business culture barriers are high for the adoption of this scenario. Moreover, it does not solve the problem of aerobically co-disposing of the POME waste. It is not considered as a plausible alternative.

Waste incinerated in controlled conditions or used for energy purposes including power generation
The characteristics of EFB – a high moisture and low calorific heating value – make it difficult to use as fuel for steam and power generation. Advanced technologies and additional measures to pre-treat the EFB to reduce the moisture content to below 40% are required. The history of biomass use in the palm oil industry is that milling factories prefer to use fibre and shells for boiler fuel due to their higher heating value, and little or no use has been made of EFB for this purpose, except where additional revenue from the CDM makes such an alternative financially viable. The Abedon mill generates all of its energy and power needs from the mesocarp fibre and shells that it produces and its remote location does not favour power generation for other users. Hence this alternative is not viable for this mill, and again it does not solve the problem of aerobically co-disposing of the POME waste.

Continuation of waste disposed on a landfill without the capture of landfill gas;
In earlier times this biomass was burned in the open air leading to extensive air pollution from the heavy white smoke that was produced. As a result the Malaysian Government has banned open air burning of EFB. However, many mills face a problem in disposing the waste as they do not possess any plantation, but only operate a mill. Plantation owners supplying the fresh palm oil fruit bunches are typically not interested in collecting the waste at the mill and disposing of it in their plantation. Thus some of the mills are left with only the option to dispose the EFB in piles to naturally decompose at their mill site, or into natural valleys where it decays, emitting biogas containing methane, a potent greenhouse gas. Due to the remote locations of these landfills the Government has not promulgated regulations requiring the capture and flaring of this gas for safety or other environmental reasons. The current practice of waste treatment of the bio-organic solid waste including the EFB, decanter sludge and boiler ashes at Abedon is to transport the waste from mill site and deposit in a managed landfill. The palm oil mill owner incurs the cost of transporting the waste to the landfill. This is a plausible alternative for disposal of the biomass waste from the palm oil mill and represents business as usual.

Waste disposed on a landfill where landfill gas is captured and flared;
Waste disposed on a landfill where landfill gas is captured and electricity generated;
Waste disposed on a landfill where landfill gas is captured and delivered to nearby industries for heat generation.
Due to the remote locations of most palm oil mills and the cost involved in installing systems to capture the landfill gas, there were no landfills that have such facilities and it is not a regulatory requirement for the palm oil mill owners to install such facilities in Malaysia. Moreover, in this remote location there is no market for any electricity or heat generated by capturing and use of the LFG. Abedon mill already has excess power capacity from in-mill boilers using mesocarp fibres and shells as fuels. The excess power generation capacity can be absorbed by the proposed in-vessel co-composting plant.

For organic waste water

Continuation of current practice of using anaerobic lagoons or open storage tanks without methane recovery and flaring
Wastewater treatment of POME in an open pond system more than 5 m in depth is the prevalent practice in palm oil mills in Malaysia. Despite numerous revisions to the allowable discharge level, the combination of anaerobic ponds and aerobic/facultative ponds has been able to meet the current permitted discharge level of biological oxygen demand (BOD) of 5,000mg/l for land application and 100mg/l for water way discharge. Pond systems are the technology of choice in the Malaysian palm oil industry as they are very low risk, and utilise a low-tech process suitable for remote installation that is typical of palm oil mills in the country. It represents business as usual at Abedon and will continue in the absence of a CDM financed alternative.

Wastewater used for co-composting (the project activity implemented without CDM);
Without CDM support this is not a plausible alternative for treatment of the POME as has been argued for bio-organic solid waste (see Step 3, "For bio-organic waste").

Anaerobic lagoons or storage tanks with methane recovery and flaring;
Anaerobic lagoons or storage tanks with methane recovery and utilization for electricity or heat generation;

Though anaerobic ponds are used in existing wastewater treatment systems, these are more like retaining ponds with minimal interference from the operator. As in the case of the biomass these alternatives are not mandated by Malaysian Government regulations and therefore have not been adopted by the Malaysian Palm Oil Industry. In addition, in this remote location there is no market for electricity or heat generated by the capturing of biogas from these lagoons

Building of a new anaerobic lagoon or open storage tanks without methane recovery and flaring;
Building of a new anaerobic lagoon or open storage tanks with methane recovery and flaring;
There are existing lagoons so there is no need to build a new facility to treat wastewater.

Aerobic treatment facility
Aerobic waste water treatments systems are suitable for relatively low BOD/COD wastes but not for the high BOD/COD wastes generated by the palm oil industry. They are used for polishing treatment after anaerobic treatment to reduce the BOD/COD to a level that is acceptable for discharge to surface waters. A fully aerobic waste water treatment process for raw POME is not technically feasible, nor would it be economically feasible at the Abedon site.

In Summary:

For Abedon the most plausible baseline scenario for treatment of the wastewater is the continuation of the use of open anaerobic lagoons or storage tanks throughout the crediting period and the most plausible baseline for treating bioorganic waste is the continuation of waste disposal at a managed landfill.

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 (combined tool to demonstrate the baseline scenarios and demonstrate additionality):

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Step 3: Investment analysis. Compare economic attractiveness of remaining alternatives

It has been shown that the only plausible scenario for the palm oil mill is to continue with business as usual for waste and wastewater treatment, which is standard industry practice and complies with all environmental regulation. There are significant technology and financial risks inherent in investing in the project and successful current business practice does not warrant exposure to such risks. Therefore it has been proved that the project is additional, the CDM incentive is driving the project activity and the project would not be undertaken without CDM financing.

However, an overview investment analysis is included to show the impact of CDM finance on the project being undertaken and how CDM financing is required to achieve minimum financial returns for the project.

The main elements included in the financial analysis shown below are:

- Initial Investment required (Capex): The project developer's estimates that MYR 10,290,000 will be required to build the co-composting facilities at Inno-Malsa. This figure includes the acquisition and deployment of machinery as well as civil works at the main facilities. This figure does not include auxiliary facilities or management offices. Should cost overruns happen, the project developer would meet the additional financial requirements
- Production costs (COGS) include the acquisition of the waste streams, labour expenses, royalties paid to technology providers, lease of land and certain equipment maintenance expenses
- All future cash flows are discounted at a 15% discount rate to be consistent with the financial benchmark

FINANCIAL ANALYSIS

Overview financial model for PDD calculations

MYR		Sep-08	Dec-08	Dec-09	Dec-10	Dec-11	Dec-12	Dec-13	Dec-14	Dec-15	Dec-16	Dec-17	Dec-18
Compost revenues			1,509,375	6,037,500	6,037,500	6,037,500	6,037,500	6,037,500	6,037,500	6,037,500	6,037,500	6,037,500	6,037,500
COGs			691,275	2,680,716	2,680,716	2,680,716	2,680,716	2,680,716	2,680,716	2,680,716	2,680,716	2,680,716	2,680,716
Operating costs			394,486	1,678,948	1,787,024	1,902,666	2,026,403	2,120,973	2,220,271	2,324,535	2,434,012	2,548,962	2,669,660
Operating cashflow		0	423,615	1,677,837	1,569,760	1,454,119	1,330,382	1,235,812	1,136,513	1,032,250	922,773	807,822	687,124
Investment		10,290,000											
Total cashflow		(10,290,000)	423,615	1,677,837	1,569,760	1,454,119	1,330,382	1,235,812	1,136,513	1,032,250	922,773	807,822	687,124
IRR	3.8%		(Figures before taxes)										
NPV	-3,626,131												
Discount rate	15%												
CDM project cashflow		(10,290,000)	293,615	1,810,606	2,353,339	2,406,234	2,445,237	2,507,809	1,981,426	1,966,905	1,944,084	1,912,809	1,872,909
IRR	15.8%		(Figures before taxes)										
NPV	316,944												

The palm oil sector is now profitable industry given high palm oil prices, due to additional demand from biodiesel refiners. The industry therefore has high expectation of returns on investment and investment payback periods. Studies on the CDM potential in waste sectors in Malaysia consider IRRs of 15% to be applicable as a benchmark for Malaysian CDM projects, and previous validated PDDs use this figure. Studies note however that the palm oil sector expects IRRs in excess of this, due to its high profitability. Therefore a project benchmark IRR of 15% has been used for conservativeness.

The project requires significant upfront investment in the composting vessel and related equipment, with revenue generated from selling fertilizer to the plantation. An overview of the NPVs and IRRs for the project, both with and without CDM revenue is shown below:

Project scenario	NPV	IRR
Without CDM financing	- MYR 3.6 million*	3.8%*
With CDM financing	MYR 0.3 million*	15.8%*

*Figures shown before taxes

There is a low return for the project, without including CDM financing, so the industry benchmark is not relevant.

Furthermore, the sensitivities shown below, indicate that either increasing revenue, or reducing costs, by more than 10% would be required to obtain an IRR in the absence of CDM financing that would reach the industry benchmark.

IRR sensitivities tables*

	Change in fertilizer revenue				
	-10%	**-5%**	**0%**	**5%**	**10%**
Without CDM financing	-11.0%	-2.4%	3.8%	8.9%	13.4%
With CDM financing	7.8%	12.0%	15.8%	19.4%	22.8%

	Change in operating costs				
	-10%	**-5%**	**0%**	**5%**	**10%**
Without CDM financing	7.4%	5.6%	3.8%	1.8%	-0.5%
With CDM financing	18.2%	17.0%	15.8%	14.5%	13.2%

*Figures shown before taxes

Step 4: Assessment whether the identified baseline scenario is common practice
The existing solid waste disposal at landfill and POME wastewater treatment system at the mill is able to comply with the legal discharge standards as stipulated by the Department of Environment, Malaysia. The open anaerobic pond system is the most common and standard practices at most palm oil mills in Malaysia. There is no legal requirement or financial incentive to compel the Abedon mill owners to implement other treatment options that will require additional investment. For Abedon the most plausible baseline scenario for treatment of the wastewater is the continuation of the use of open anaerobic lagoons or storage tanks throughout the crediting period and the most plausible baseline for treating bioorganic waste is a managed landfill.

Step 5: Impact of CDM Registration
CDM Registration of this project activity overcomes the financial and technical barriers that have so far prevented investors with experience in aerobic co-composting waste treatment and bio-organic fertilizers to come together to build and operate a treatment facility which will eliminate methane emissions from the disposal of biomass and organic liquid wastes that represent business as usual at the Abedon site. The experience brought by carbon investors together with their technology expertise and technical and financial resources will make possible the implementation of the proposed CDM project.

B.6. Emission reductions:

B.6.1. Explanation of methodological choices:

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The methodology to be used is AM0039 "Methane emissions reduction from organic waste water and bioorganic solid waste using co-composting". The proposed project activity meets all the applicability requirements stipulated by the approved methodology AM0039.

Baseline emissions
The following types of baseline emissions will be accounted under this methodology.

(a) Methane (CH4) emissions from waste water in anaerobic lagoons or open storage tanks;
(b) Methane (CH4) emissions from decay of bioorganic solid waste in disposal sites;
(c) CO2 emissions from transportation of organic wastewater and bioorganic solid waste;
(d) CO2 emissions from fossil fuels used for energy requirements and
(e) CO2 emissions from grid electricity consumption.

Total baseline emissions are expressed as:

$$BE_y = BE_{CH4,WW,y} + BE_{CH4,SW,y} + BE_{CO2,Trans,y} + BE_{CO2,FF,y} + BE_{CO2,Elec,y}$$

where:

BE_y is the total baseline emissions during the year y, (tCO2e)

$BE_{CH4,WW,y}$ is the baseline methane emissions from existing open lagoon or open storage tanks during the year y (tCO2e)

$BE_{CH4,SW,y}$ is the baseline methane emissions from decay of bio-organic solid waste during the year y (tCO2e)

$BE_{CO2,Trans,y}$ is the baseline CO2 emissions from transportation of organic wastewater and bioorganic solid waste during the year y (tCO2e)

$BE_{CO2,FF,y}$ is the baseline CO2 emissions from use of fossil fuels during the year y (tCO2)

$BE_{CO2,Elec,y}$ is the baseline CO2 emissions from grid electricity consumption during the year y (tCO2)

The above emissions are calculated as explained below:

(a) Methane (CH4) emissions from wastewater in open storage systems ($BE_{CH4,WW,y}$)

The baseline methane emissions from anaerobic lagoons or storage tanks are estimated based on the chemical oxygen demand (COD) of the effluent that would enter the lagoon in the absence of the project activity, the maximum methane producing capacity (B_o) and a methane conversion factor (MCF) that expresses what proportion of the effluent would be anaerobically digested in the open lagoons.

The baseline methane emissions are calculated using the following equation:

$$BE_{CH4,WW,m} = COD_{available,m} \cdot B_o \cdot MCF_{baseline} \cdot GWP_{CH4}$$

where:

$BE_{CH4,WW,m}$ is the baseline monthly methane emissions from wastewater (tCO2e)

$COD_{available,m}$ is the monthly Chemical Oxygen Demand available for conversion which is equal to the monthly COD of the wastewater used for co-composting $COD_{baseline,m}$ plus COD carried on from the previous month (tCOD)

$COD_{baseline,m}$ is the monthly Chemical Oxygen Demand of effluent entering anaerobic lagoons or storage tanks (measured in the project activity) (tCOD)

B_o is the maximum methane producing capacity of the inlet effluent (tCH4/tCOD)

$MCF_{baseline}$ is the methane conversion factor of the baseline storage system (fraction)

GWP_{CH4} is the Global Warming Potential of methane, default value 21

$COD_{baseline,m}$ is to be directly measured in the project as the baseline activity level since the effluent that goes into the anaerobic lagoon or storage tanks in the baseline situation is the same as the one that goes into the project. $COD_{baseline,m}$ is calculated as the product of $COD_{c,baseline}$ concentration (kgCOD/m^3) in the wastewater input to the project and the flow rate F_{dig} (m^3/month).

Since the effluent resides in the Abedon lagoons for more than 30 days, the amount of organic matter available for conversion to methane $COD_{available,m}$ is assumed to be equal to the amount of organic matter produced during the month ($COD_{baseline,m}$ input to the project) plus the organic matter that may remain in the system from previous months.

The amount of organic matter consumed during the month is equal to the amount available for conversion $COD_{available,m}$ multiplied by $MCF_{monthly}$. The amount of organic matter carried over from one month to the next equals to the amount available for conversion minus the amount consumed and minus the amount removed from the anaerobic lagoon or storage tank. In the case of the emptying of the anaerobic lagoon or storage tank, the accumulation of organic matter restarts with the next inflow.

The default IPCC value for B_o is 0.25kg CH4/kg COD. Taking into account the uncertainty of this estimate, a value of 0.21 kg CH4/kg COD is assumed for this project activity as a conservative assumption for B_o.

$MCF_{baseline,m}$ is estimated as the product of the fraction of anaerobic degradation due to depth (f_d) and the fraction of anaerobic degradation due to temperature ($f_{t,monthly}$):

$$MCF_{baseline,m} = f_d \cdot f_{t,monthly} \cdot 0.89$$

where:
f_d is the fraction of anaerobic degradation due to depth as following Table
$f_{t,monthly}$ is the fraction of anaerobic degradation due to temperature
0.89 is an uncertainty conservativeness factor (for an uncertainty range of 30% to 50%) to account for the fact that the equation used to estimate $f_{t,monthly}$ assumes full anaerobic degradation at 30 ºC.

	Deep > 5m	Medium Depth 1-5m	Small depth < 1 m
Fraction of degradation under anaerobic conditions due to depth of anaerobic lagoons or	70%	50%	0

storage tank			

$f_{t,monthly}$ is calculated as follows:

$$f_{t,monthly} = \exp\left[\frac{E\cdot(T_2 - T_1)}{R\cdot T_1\cdot T_2}\right]$$

where:
E Activation energy constant (15,175 cal/mol)
T_2 Ambient temperature (Kelvin) for the climate
T_1 303.16 (273.16° + 30°)
R Ideal gas constant (1.987 cal/ K mol).

(1) The monthly average temperature for the area is obtained from published national weather service information (See Annex 3).
(2) Monthly temperatures are used to calculate a monthly van't Hoff – Arrhenius '$f_{t,monthly}$' factor above. A minimum temperature of 10 °C is used. Months where the average temperature is less than 10 ºC, $f_{t,monthly} = 0$. The value of $f_{t,monthly}$ to be used cannot exceed unity. Monthly values are used in the calculations for this project activity.

(b) Methane (CH4) emissions from decay of bioorganic solid waste in disposal sites ($BE_{CH4,SW,y}$)

The amount of methane that would be generated each year in absence of project activity ($BE_{CH4,SW,y}$) is calculated as per the following equation:

$BE_{CH4,SW,y} = BE_{CH4,SWDS,y} - MD_{reg}$

Where:
$BE_{CH4,SWDS,y}$ is the methane generation from the landfill in the absence of the project activity at year "y" calculated as per the *"Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site".*
And
MD_{reg} is the methane that would be destroyed in the absence of the project activity in year y (tCH4)

The tool estimates methane generation adjusted for, using adjustment factor (f) any landfill gas in the baseline that would have been captured and destroyed to comply with relevant regulations or contractual requirements, or to address safety and odour concerns. As this is already accounted for in the equation directly above, "f" in the tool shall be assigned a value 0.

In the calculation of type of waste streams, we are only using EFB as the only waste stream, although, we also include sludge and boiler ashes as well. The model calculates the methane generation based on the actual waste streams $W_{j,x}$ diverted from the landfill in the most recent year and all previous years since the project start (x=1 to x=y).

The amount of methane produced in a year is calculated as follows:

$$BE_{CH4,SWDS,y} = \varphi\cdot(1-f)\cdot GWP_{CH4}\cdot(1-OX)\cdot\frac{16}{12}\cdot F\cdot DOC_f\cdot MCF\cdot\sum_{x=1}^{y}\sum_{j} W_{j,x}\cdot DOC_j\cdot e^{-k_j\cdot(y-x)}\cdot\left(1-e^{-k_j}\right)$$

where:

$BE_{CH4,SWDS,y}$	is the amount of methane emissions avoided during the year *y* from preventing waste disposal at the solid waste disposal site (SWDS) during the period from the start of the project activity to the end of the year y (tCO_2e)
φ	is the model correction factor (default 0.9) to correct for the model-uncertainties
F	is the fraction of methane in the SWDS gas, IPCC default value 0.5
DOC_j	is the percentage of degradable organic carbon (by weight) in the waste type j
DOC_f	is the fraction of DOC that can decompose, default value 0.5
MCF	is the Methane Correction Factor (fraction)
GWP_{CH4}	is the global warming potential for Methane, IPCC default value 21
$W_{j,x}$	is the amount of organic waste type j prevented from disposal in the SWDS during the year x (tons)
kj	is the decay rate for waste stream type j
j	is the waste type distinguished into the waste categories (from A to D), as illustrated in the Table 4 below.
x	is the year during the crediting period: x runs from the first year of first crediting period (x=1) to the year for which emissions are calculated (x=y)
y	is the year for which methane emissions are calculated
f	Fraction of methane captured at the SWDS and flared, combusted or used in another manner, assigned value of 0
OX	Oxidation factor (reflecting the amount of methane from the landfill that is oxidised in the soil or other material covering the waste)

In cases where regulatory or contractual requirements do not specify $MD_{reg,y,}$ an Adjustment Factor (AF) shall be used and justified, taking into account the project context. In doing so, the project participant should take into account that some of the methane generated by the landfill may be captured and destroyed to comply with other relevant regulations or contractual requirements, or to address safety and odor concerns.

$$MD_{reg,y} = BE_{CH4,SW,y} * AF$$

where:
AF is Adjustment Factor for $BE_{CH4,SW,y}$ (%)

AF is defined as the ratio of the destruction efficiency of the collection and destruction system mandated by regulatory or contractual requirement to that of the collection and destruction system in the project activity.

Model Correction Factor (φ)
Oonk et el. have validated several landfill gas models based on 17 realized landfill gas projects3. The mean relative error of multi-phase models was assessed to be 18%. Given the uncertainties associated with the model and in order to estimate emission reductions in a conservative manner, a discount of 10% should be applied to the model results, i.e. φ = 0.9.

Methane correction factor (MCF)
The methane correction factor (MCF) accounts for the fact that unmanaged landfills produce less methane from a given amount of waste than managed landfills, because a larger fraction of waste decomposes aerobically in the top-layers of unmanaged landfills. The proposed default values for MCF are listed in the table below.

Solid Waste Disposal Site (SDWS) Classification and Methane Correction Factors

Type of site	MCF default values
Managed site	1.0
Unmanaged site – deep (> 5 m waste)	0.8
Unmanaged site – shallow (< 5 m waste)	0.4
Note: Managed SWDS must have controlled placement of waste (i.e. waste directed to specific deposition areas, a degree of control of scavenging and a degree of control of fires) and will include some of the following: cover material, mechanical compacting or levelling of waste.	

Source: Table 5.1 in the 2000 IPCC Good Practice Guidance

Degradable carbon content in waste (DOC_j) and decay rates (k_j)
In the "Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site", it is recommended that in the case of empty fruit bunches, project participants use the IPCC default value for DOC_j that corresponds with wood. This equates to 0.43.

For the decay rate k_j, the IPCC suggested value is that used for wood, until the empty fruit bunches are appropriately characterized by an adequate laboratory test. This is 0.035.

Calculation of F
This factor reflects the fact that some degradable organic carbon does not degrade, or degrades very slowly, under anaerobic conditions in the SWDS. A default value of 0.5 is recommended by IPCC.

Fraction of degradable organic carbon dissimilated (DOCf)
The decomposition of degradable organic carbon does not occur completely and some of the potentially degradable material always remains in the site even over a very long period of time. The revised IPCC Guidelines propose a default value of 0.5 for DOCf.

Oxidation Factor (OX)
The "*Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site*" recommends using an OX of 0.1 for managed solid waste disposal sites that are covered with oxidizing material such as soil or compost, and 0 for other types of solid waste disposal sites. As there is no covering oxidizing material in this case, 0 is used as the oxidation factor in this case.

(c) *CO2 emissions from transportation of organic wastewater and bioorganic solid waste ($BE_{CO2,Trans,y}$)*

The baseline emissions from transportation are to be calculated using distance travelled by trucks and the fuel emission factor, as follows:

$$BE_{CO2,Trans,y} = \sum_i N_{vehicles,i,y} \cdot Dist_{i,y} \cdot FC_{i,Trans} \cdot NCV_i \cdot EF_{CO2,i}$$

where:

$N_{vehicles,i,y}$ is the number of vehicle trips used for transportation, with similar loading capacity
$Dist_{i,y}$ is the average distance per trip travelled by transportation vehicles type *i* in the baseline scenario during the year *y* (km)
FC_i is the vehicle fuel consumption in volume or mass units per km for vehicle type *i*
NCV_i is the net calorific value of fuel type *i* in TJ per volume or mass units
$EF_{CO2,i}$ is the CO2 emission factor of the fossil fuel type *i* used in transportation vehicles, (tCO2e/TJ)

(d) *CO2 emissions from fossil fuels used for energy requirements ($BE_{CO2,FF,y}$)*

CO2 emissions from fossil fuel used in the baseline for energy requirements such as heating shall be calculated as follows:

$$BE_{CO2,FF,y} = \sum_i FC_{i,y} \cdot NCV_i \cdot EF_{CO2,i}$$

where:

$FC_{i,y}$	is the baseline fossil fuels consumed of type *i* for energy requirements during the year *y* in mass or volume units
NCV_i	is the Net Calorific Value (energy content) in TJ of fuel type *i*, per mass unit or volume unit
$EF_{CO2,i}$	is the CO2 emission factor per unit of energy of the fuel *i* (tCO2e/TJ)

Where available, local values of NCV_i and $EF_{CO2,i}$ should be used. If no such values are available, country specific values (see e.g. IPCC Good Practice Guidance) are preferable to latest versions of IPCC Guidelines values.

(e) *CO2 emissions from grid electricity consumption ($BE_{CO2,Elec,y}$)*

In case electricity is consumed for energy requirements in the baseline, CO2 emissions from electricity consumption shall be calculated as follows:

$$BE_{CO2,Elec,y} = EC_y \cdot EF_{GridElec,y}$$

where:

EC_y	is the baseline electricity consumption during the year y (MWh)
$EF_{GridElec,y}$	is the grid electricity emission factor for the year y (tCO_2/MWh)

In cases where electricity is purchased from the grid, the emission factor $EF_{GridElec,y}$ should be calculated according to the “Tool for calculation of emission factor for electricity systems”.

Project emissions

The following types of project emissions will be accounted under this methodology:

(a) N_2O emissions from composting process
(b) CH_4 emissions from composting process
(c) CH_4 emissions from leaked waste water
(d) CO_2 emissions from transportation
(e) CO_2 emissions from fossil fuels consumption
(f) CO_2 emissions from grid electricity consumption

Total project emissions are expressed as

$$PE_y = PE_{N2O,Comp,y} + PE_{CH4,Comp,y} + PE_{CH4,Bww,y} + PE_{CO2,Trans,y} + PE_{CO2,FF,y} + PE_{CO2,Elec,y}$$

where:

PE_y	is the total project emissions during the year y, (tCO2e)
$PE_{N2O,Comp,y}$	is the N_2O emissions from composting of bio-organic solid waste during the year y (tCO2e)
$PE_{CH4,Comp,y}$	is the CH_4 emissions from composting of bio-organic solid waste during the year y

(tCO2e)

$PE_{CH4,Bww,y}$	is the CH_4 emissions from leaked waste water discharged after the project activity during the year y (tCO2e)
$PE_{CO2,Trans,y}$	is the CO_2 emissions from transportation in the project situation during the year y (tCO2e)
$PE_{CO2,FF,y}$	is the CO_2 emissions from use of fossil fuels in the project situation during the year y (tCO2)
$PE_{CO2,Elec,y}$	is the CO_2 emissions from grid electricity consumption in project situation during the year y (tCO2)

The above emissions will be calculated as explained below:

(a) N_2O emissions from composting ($PE_{N2O,Comp,y}$):

N_2O emissions from composting during the year y are calculated as follows:

During the storage of waste in collection containers as part of the composting process itself and during the application of compost, N_2O emissions might occur. A default N_2O emission factor of 0.043 kg N_2O per tonne of compost and calculate emissions as follows:

$$PE_{N2O,Comp,y} = Q_{Compost,y} \cdot EF_{N2O,Comp} \cdot GWP_{N2O}$$

where:

$Q_{Compost,y}$	is the total quantity of compost produced during the year y, (tons of compost)
$EF_{N2O,Comp}$	is the emission factor for N2O emissions from composting process (tN2O/ton of compost)
GWP_{N2O}	is the global warming potential of N2O, default value 310

(b) *CH_4 emissions from composting ($PE_{CH4,Comp,y}$):*

During the composting process, aerobic conditions are neither completely reached in all areas nor at all times. Pockets of anaerobic conditions – isolated areas in the composting heap where oxygen concentrations are so low that the biodegradation process turns anaerobic – may occur. The emission behavior of such pockets is comparable to the anaerobic situation in a landfill. This is a potential emission source for methane similar to anaerobic conditions which occur in unmanaged landfills. Through predetermined sampling procedures the percentage of waste that degrades under anaerobic conditions can be determined. Using this percentage, project methane emissions from composting process are calculated, as follows:

$$PE_{CH4,Comp,y} = PE_{CH4,Anaerobic,y} \cdot GWP_{CH4} \cdot S_{a,y}$$

where:

$PE_{CH4,Anaerobic,y}$	is the quantity of methane that would be generated from anaerobic pockets in the composting process, during the year *y* (tCH_4)
GWP_{CH4}	is the global warming potential of CH_4, default value 21
$S_{a,y}$	is the share of waste that degrades under anaerobic conditions in the composting plant during the year *y* (%)

The amount of methane that is generated in anaerobic pockets ($PE_{CH4,Anaerobic,y}$) is calculated for each year with a multi-phase model. The model is based on a first order decay equation. It differentiates between the different types of waste *j* with respectively different decay rates k_j (fast, moderate, slow) and fraction of degradable organic carbon (DOC_j). The model calculates the methane generation based on the actual waste streams $A_{project,j,x}$ disposed in the most recent year (*y*) and all previous years since the project start (x=1 to x=y). The amount of methane produced is calculated as follows:

$$PE_{CH4,Anaerobic,y} = \varphi \cdot \frac{16}{12} \cdot F \cdot DOC_f \cdot MCF \cdot GWP_{CH4} \cdot \sum_{x=1}^{y} \sum_{j=A}^{D} A_{project,j,x} \cdot DOC_j \cdot \left(1 - e^{-k_j}\right) \cdot e^{-k_j(y-x)}$$

Variables used in the above equation are analogous to those of the similar equation above.

Calculation of $S_{a,y}$:

$S_{a,y}$ is determined by a combination of measurements and calculations. Bokhorst et al6 and Richard et al show that if oxygen content is below 5% - 7.5%, aerobic composting processes are replaced by anaerobic processes. To determine the oxygen content during the process, project participants shall measure the oxygen content according to a predetermined sampling scheme and frequency.

These measurements should be undertaken for each year of the crediting period and recorded each year. The percentage of the measurements that show oxygen content below 10%8 is presumed to be equal to the share of waste that degrades under anaerobic conditions (i.e. that degrades as if it were landfilled), hence the emissions caused by this share are calculated as project emissions *ex-post* on an annual basis:

$S_{a,y} = S_{OD,y} / S_{total,y}$

where:

$S_{OD,y}$	is the number of samples in year *y* with an oxygen deficiency (i.e. oxygen content below 10%)
$S_{total,y}$	is the total number of samples taken in year *y*, where $S_{total,y}$ should be chosen in a manner that ensures the estimation of $S_{a,y}$ with 20% uncertainty at a 95% confidence level.

(c) CH4 emissions from the leaked wastewater ($PE_{CH4,bww,y}$):

Projects such as composting will usually have no wastewater discharge but there is a possibility that a small quantity of leaked wastewater is collected from windrows or as a balance of waste water and this leak wastewater may cause CH_4 emissions.
CH_4 emissions from leak and/or balance of waste water shall be calculated as follows.

$$PE_{CH4,BWW,y} = COD_{outlet,total,y} \cdot B_o \cdot MCF_{outlet} \cdot GWP_{CH4}$$

where:

$PE_{CH4,BWW,y}$	is the project methane emissions from wastewater during the year *y* (tCO2e)
$COD_{outlet,total,y}$	is the outlet total COD of the wastewater during the year *y* (tCOD)
B_o	is the outlet maximum methane producing capacity of wastewater (tCH4/tCOD)
MCF_{outlet}	is the methane conversion factor of the storage system (fraction)
GWP_{CH4}	is the Global Warming Potential of methane

MCF_{outet} is to be estimated in the same manner as that of $MCF_{baseline,m}$ in the baseline.

(d) CO2 emissions from transportation ($PE_{CO2,Trans,y}$):

The project emissions from transportation are to be calculated using the total distance and local, national or latest version of IPCC Guidelines default values for transportation fuel, as follows:

$$PE_{CO2,Trans,y} = \sum_i N_{vehicles,i,y} \cdot Dist_{i,y} \cdot FC_i \cdot NCV_i \cdot EF_{CO2,i}$$

where:

$N_{vehicles,i,y}$ is the number of vehicle trips used for transportation, with similar loading capacity

$Dist_{i,y}$ is the average distance per trip travelled by transportation vehicles type *i* in the project scenario during the year *y* (km)

FC_i is the vehicle fuel consumption in volume or mass units per km for vehicle type *i*

NCV_i is the net calorific value of fuel type *i* in TJ per volume or mass units

$EF_{CO2,i}$ is the CO2 emission factor of the fossil fuel type *i* used in transportation vehicles, (tCO2e/TJ)

(e) CO2 emissions from fossil fuels used for energy requirements ($PE_{CO2,FF,y}$):

CO_2 emissions from fossil fuel used in the project for energy requirements such as heating shall be calculated as follows:

$$PE_{CO2,FF,y} = \sum_i FC_{i,project,y} \cdot NCV_i \cdot EF_{CO2,i}$$

where:

$FC_{i,project,y}$ is the fossil fuels consumed of type *i* for energy requirements during the year *y* in mass or volume units

NCV_i is the Net Calorific Value (energy content) in TJ of fuel type *i*, per mass unit or volume unit

$EF_{CO2,i}$ is the CO2 emission factor per unit of energy of the fuel *i*. (tCO2e/TJ)

Where available, local values of NCV_i and $EF_{CO2,i}$ should be used. If no such values are available, country specific values (see e.g. IPCC Good Practice Guidance) are preferable to the latest version of IPCC Guidelines world-wide default values.

(f) CO2 emissions from electricity consumption (PECO2,Elec,y):

In case electricity is consumed for energy requirements in the baseline, CO2 emissions from electricity consumption shall be calculated as follows:

$$PE_{CO2,Elec,y} = EC_{project,y} \cdot EF_{GridElec,y}$$

where:

$EC_{project,y}$ is the project electricity consumption during the year *y* (MWh)

$EF_{GridElec,y}$ is the grid electricity emission factor for the year *y* (tCO2/MWh)

In cases where electricity is purchased from the grid, the emission factor $EF_{GridElec,y}$ should be calculated according to the “Tool for calculation of emission factor for electricity systems”.

Leakage

No leakage effects need to be accounted under this methodology.

Emission reductions

Emission reductions are calculated as follows:

$$ER_y = BE_y - PE_y - LE_y$$

Where:
ER_y = Emission reductions during the year y (tCO2/yr)
BE_y = Baseline emissions during the year y (tCO2/yr)
PE_y = Project emissions during the year y (tCO2/yr)
LE_y = Leakage emissions during the year y (tCO2/yr)

Changes Required For Methodology Implementation in 2nd And 3rd Crediting Periods

Project participants shall check for updates of default values of IPCC used in this methodology. In case the default values are revised by IPCC, project participants shall use only revised values during methodology implementation in 2nd and 3rd crediting periods.

B.6.2. Data and parameters that are available at validation:
(Copy this table for each data and parameter)

Data / Parameter:	B_o
Data unit:	Kg CH4 per Kg COD
Description:	the maximum methane producing capacity of the inlet effluent to the anaerobic waste water treatment facility
Source of data used:	IPCC default value
Value applied:	0.21
Justification of the choice of data or description of measurement methods and procedures actually applied :	The conservative value
Any comment:	

Data / Parameter:	GWP_{CH4}
Data unit:	tCO2e
Description:	is the Global Warming Potential of methane
Source of data used:	IPCC Default value
Value applied:	21
Justification of the choice of data or description of measurement methods and procedures actually applied :	Normal practice
Any comment:	

Data / Parameter:	f_d

Data unit:	Fraction
Description:	is the fraction of anaerobic degradation due to depth
Source of data used:	Default value given in AM0039
Value applied:	0.7
Justification of the choice of data or description of measurement methods and procedures actually applied :	The depth of anaerobic POME treatment ponds in the Abedon factory and a conventional depth of the ponds throughout the Malaysian Palm Oil Industry is greater than 5 meters. Hence the default value for f_d is 0.7 for this depth.
Any comment:	

Data / Parameter:	**Φ**
Data unit:	
Description:	
Source of data used:	
Value applied:	0.9
Justification of the choice of data or description of measurement methods and procedures actually applied :	Normal practice
Any comment:	

Data / Parameter:	**GWP_{N2O}**
Data unit:	(tCO_2/tN_2O)
Description:	is the Global Warming Potential of nitrous oxide,
Source of data used:	IPCC
Value applied:	310
Justification of the choice of data or description of measurement methods and procedures actually applied :	Normal practice
Any comment:	

Data / Parameter:	**NCV_i * $EF_{CO2,i}$**
Data unit:	(MJ/litre) and (kgCO2/MJ) = (kgCO2/litre)
Description:	Emission factor for diesel fuel
Source of data used:	United States Environmental Protection Agency (“EPA”)
Value applied:	2.672
Justification of the choice of data or description of measurement methods and procedures actually applied :	Normal practice
Any comment:	

Data / Parameter:	D_{fuel}
Data unit:	kg/l
Description:	Density of diesel fuel
Source of data used:	http://www.simetric.co.uk/si_liquids.htm
Value applied:	0.82 kg/l at 20^{o} C
Justification of the choice of data or description of measurement methods and procedures actually applied :	
Any comment:	

Data / Parameter:	$EF_{c,N2O}$
Data unit:	(tN_2O/t compost)
Description:	Emission factor for N_2O emissions from the composting process
Source of data used:	AM0025
Value applied:	0.043
Justification of the choice of data or description of measurement methods and procedures actually applied :	Default value recommended in AM0025
Any comment:	

Data / Parameter:	MCF
Data unit:	Factor
Description:	Methane Correction Factor
Source of data used:	IPCC
Value applied:	0.8
Justification of the choice of data or description of measurement methods and procedures actually applied :	The Abedon landfill is unmanaged with levelling of waste and some compaction and is 7 meters in depth
Any comment:	

Data / Parameter:	F
Data unit:	Fraction
Description:	is the fraction of methane in the landfill gas, IPCC default value 0.5
Source of data used:	IPCC default
Value applied:	0.5
Justification of the choice of data or description of measurement methods and procedures actually applied :	This is the conservative value

Any comment:	

Data / Parameter:	**DOC_j**
Data unit:	Percent
Description:	is the percentage of degradable organic carbon (by weight) in EFB
Source of data used:	IPCC default value
Value applied:	43% (wet weight)
Justification of the choice of data or description of measurement methods and procedures actually applied :	The "Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site" recommends using the value corresponding to wood in the case of empty fruit bunches as a default.
Any comment:	

Data / Parameter:	**DOC_f**
Data unit:	Fraction
Description:	is the fraction of DOC that can decompose
Source of data used:	IPCC default value
Value applied:	0.5
Justification of the choice of data or description of measurement methods and procedures actually applied :	
Any comment:	

Data / Parameter:	**AF**
Data unit:	Factor
Description:	Regulatory requirements relating to landfill gas collection and flaring for EFB landfills. AF is defined as the ratio of the destruction efficiency of the collection and destruction system mandated by regulatory or contractual requirement to that of the collection and destruction system in the project activity.
Source of data used:	Local or national authorities
Value applied:	0
Justification of the choice of data or description of measurement methods and procedures actually applied :	There is no regulatory requirement for capture and flaring of LFG at EFB landfills in Malaysia
Any comment:	The 'Adjustment Factor' shall be revised at the start of each new crediting period taking into account the amount of GHG flaring that occurs as part of common industry practice and/or regulation at that point in the future.

Data / Parameter:	**OX**
Description:	Oxidation factor (reflecting the amount of methane from SWDS that is oxidized in the soil or other material covering the waste)

Source of data:	Conduct a site visit at the solid waste disposal site in order to assess the type of cover of the solid waste disposal site. Use the IPCC 2006 Guidelines for National Greenhouse Gas Inventories for the choice of the value to be applied.
Value applied:	0
Justification of the choice of data or description of measurement methods and procedures actually applied :	The "tool to determine methane emissions avoided from dumping waste at a solid waste disposal site" recommends using 0.1 for managed solid waste disposal sites that are covered with oxidizing material such as soil or compost, and 0 for other types of solid waste disposal sites. The EFB landfills are not covered with any oxidizing material such as soil or compost, hence a value of 0 is used.
Any comment:	

Data / Parameter:	**f**
Data unit:	-
Description:	Fraction of methane captured at the SWDS and flared, combusted or used in another manner
Source of data used:	-
Value applied:	0
Justification of the choice of data or description of measurement methods and procedures actually applied :	The "tool to determine methane emissions avoided from dumping waste at a solid waste disposal site" estimates methane generation adjusted for, using adjustment factor (f) any landfill gas in the baseline that would have been captured and destroyed to comply with relevant regulations or contractual requirements, or to address safety and odour concerns. As this is already accounted for in the AM0039 methodology, "f" in the tool shall be assigned a value 0.
Any comment:	

B.6.3 Ex-ante calculation of emission reductions:

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As described in section B.6.1, the emission reductions are calculated according to methodology AM0039 "Methane emissions reduction from organic waste water and bioorganic solid waste using co-composting". The ex-ante calculation of emission reductions are completed with the following steps:

Baseline emissions

The following types of baseline emissions will be accounted under this methodology.

(a) Methane (CH4) emissions from waste water in anaerobic lagoons or open storage tanks;
(b) Methane (CH4) emissions from decay of bioorganic solid waste in disposal sites;
(c) CO2 emissions from transportation of organic wastewater and bioorganic solid waste;
(d) CO2 emissions from fossil fuels used for energy requirements and
(e) CO2 emissions from grid electricity consumption.

Total baseline emissions are expressed as:

$$BE_y = BE_{CH4,WW,y} + BE_{CH4,SW,y} + BE_{CO2,Trans,y} + BE_{CO2,FF,y} + BE_{CO2,Elec,y}$$

For this project activity all of the electricity energy use in the baseline and in the project activity is from renewable resources (from fibre and husks produced in the processing of Fresh Fruit Bunches) and can be neglected. There is no use of fossil fuels on this plant site for heating purposes. Hence items (d) and (e) are zero, as well as for the pumping of organic waste water (part of (c)). The above equation becomes:

$$BE_y = BE_{CH4,WW,y} + BE_{CH4,SW,y} + BE_{CO2,TransEFB,y}$$

Baseline Assumptions:

1. Raw POME concentration is 50,000 mg/L (before the POME sludge decanter) and after anaerobic/aerobic treatment the concentration of COD in the effluent is less than 100 mg/l.
2. The average amount of FFB processed by the Abedon palm oil mill is estimated to be 210,000 t/year
3. The average amount of POME generated is 0.70 m3/t Fresh Fruit Bunches (as published by the Malaysian Department of Environment. Industrial Processes & the environment. Handbook number 3. Crude Palm Oil Industry). With the present production level of 210,000 t FFB/year ($W_{FFB,y}$), the annual volume of POME ($V_{POME,y}$) is 147,000 m^3 /year. Ex-ante calculations assume constant monthly amount throughout the year.
4. The average amount of EFB generated is 0.23 /t of FFB, the annual amount of EFB is 48,300 t/year
5. Average monthly temperatures are taken from the nearest meteorological station at Sandakan (see Annex 3)

(a) Methane (CH4) emissions from wastewater in open storage systems ($BE_{CH4,WW,y}$)

The baseline methane emissions from anaerobic lagoons or storage tanks are estimated based on the chemical oxygen demand (COD) of the effluent that would enter the lagoon in the absence of the project activity, the maximum methane producing capacity (B_o) and a methane conversion factor (MCF) that expresses what proportion of the effluent would be anaerobically digested in the open lagoons.

The baseline methane emissions are calculated using the following equation:

$$BE_{CH4,WW,m} = COD_{available,m} \cdot B_o \cdot MCF_{baseline} \cdot GWP_{CH4}$$

$MCF_{baseline,m}$ is estimated as the product of the fraction of anaerobic degradation due to depth (f_d) and the fraction of anaerobic degradation due to temperature ($f_{t,monthly}$):

$$MCF_{baseline,m} = f_d \cdot f_{t,monthly} \cdot 0.89$$

where:

$f_{t,monthly}$ is calculated as follows:

$$f_{t,monthly} = \exp\left[\frac{E \cdot (T_2 - T_1)}{R \cdot T_1 \cdot T_2}\right]$$

Month	**Average Temperature (°K)**[1]	**$F_{t,monthly}$**
January	299.5	0.745
February	300	0.777
March	300.5	0.811
April	301.5	0.882
May	301.5	0.882
June	301	0.846

[1] See Annex 3 for monthly average temperature records for Sandakan – the nearest meteorological station

July	301	0.846
August	301	0.846
September	301	0.846
October	300.5	0.811
November	300.5	0.811
December	300	0.777
Average		**0.823**

Parameter values used to calculate ex-ante baseline emissions for $BE_{CH4,WW,y}$

Parameter	Value
COD $_{influent}$ (mg/l)	50,000
COD $_{effluent}$ (mg/l)	100
Yearly volume of POME (m^3) $V_{POME,y}$	147,000
B_o	0.21
f_d	0.7
f_t (yearly average)	0.823
GWP_{CH4}	21

$BE_{CH4,\ WW,y}$ = 147,000 * ((50,000 – 100) / 1,000,000) * 0.21 * (0.7 * 0.823 * 0.89) * 21
$BE_{CH4,\ WW,y}$ = **16,586 tCO2e/yr**

Ex-ante estimates of baseline emissions for $BE_{CH4,WW,y}$

Year	Baseline emissions $BE_{CH4,WW,y}$ (tCO_2e/yr)
Year 1	16,586
Year 2	16,586
Year 3	16,586
Year 4	16,586
Year 5	16,586
Year 6	16,586
Year 7	16,586
Year 8	16,586
Year 9	16,586
Year 10	16,586

(b) Methane (CH4) emissions from decay of bioorganic solid waste in disposal sites ($BE_{CH4,SW,y}$)

The amount of methane that would be generated each year in absence of project activity ($BE_{CH4,SW,y}$) is calculated as per the following equation:

$BE_{CH4,SW,y} = BE_{CH4,SWDS,y} - MD_{reg}$

Where:
$BE_{CH4,SWDS,y}$ is the methane generation from the landfill in the absence of the project activity at year "y" calculated as per the *"Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site".*

And
MD_{reg} is the methane that would be destroyed in the absence of the project activity in year y (tCH4)
$MD_{reg,y} = BE_{CH4,SW,y} * AF$

The amount of methane produced in a year is calculated as follows:

$$BE_{CH4,SWDS,y} = \varphi \cdot (1-f) \cdot GWP_{CH4} \cdot (1-OX) \cdot \frac{16}{12} \cdot F \cdot DOC_f \cdot MCF \cdot \sum_{x=1}^{y} \sum_{j} W_{j,x} \cdot DOC_j \cdot e^{-k_j \cdot (y-x)} \cdot (1-e^{-k_j})$$

There is no regulatory requirement in Malaysia to capture and flare landfill gas and no provision has been made to capture and flare LFG at the Abedon EFB landfill site. Hence AF = 0 and $MD_{reg,y} = 0$.

Parameter values used to calculate ex-ante baseline emissions for $BE_{CH4,SW,y}$

Parameter	Value
Φ	0.9
$A_{j,x}$	48,300
MCF	0.8
DOC_f	0.5
AF	0
GWP_{CH4}	21
F	0.5
DOC_j	0.43
k_j	0.035
OX	0
f	0

Table B.6.3-8. Ex-ante estimates of baseline emissions for $BE_{CH4,SW,y}$

Year	**Baseline emissions $BE_{CH4,SW,y}$ (tCO_2e/yr)**
Year 1	4,500
Year 2	8,846
Year 3	13,042
Year 4	17,094
Year 5	21,006
Year 6	24,784
Year 7	28,432
Year 8	31,954
Year 9	35,356
Year 10	38,640

(c) *CO2 emissions from transportation of organic wastewater and bioorganic solid waste ($BE_{CO2,Trans,y}$)*

The baseline emissions from transportation are to be calculated using distance travelled by trucks and the fuel emission factor, as follows:

$$BE_{CO2,Trans,y} = \sum_i N_{vehicles,i,y} \cdot Dist_{i,y} \cdot FC_{i,Trans} \cdot NCV_i \cdot EF_{CO2,i}$$

The quantity of EFB transported to the plantation landfill = 48,300 tpy
Number or round trips for 5 tonne truck = 48,300 / 5 = 9,660 trips/yr
Round trip distance = 6 km

Parameter values used to calculate ex-ante baseline emissions for $BE_{CO2,TransEFB,y}$

Parameter	Value
$N_{vehicles,i,y}$	9,660
$Dist_{i,y}$	6km
$FC_{i,TransEFB}$	0.2
NCV_i * $EF_{CO2,i}$ * D_{fuel} (kgCO2e/litre)	2.672

$BE_{CO2,TransEFB,y}$ = 9,660 * 6 * 0.2 * 2.672 / 1,000

$BE_{CO2,TransEFB,y}$ = **31tCO2e/yr**

Since this is such a small amount and for conservative purposes, $BE_{CO2,TransEFB,y}$ is taken as zero.

Ex-ante estimates of baseline emissions for $BE_{CO2,TransEFB,y}$

Year	Baseline emissions $BE_{CO2,TransEFB,y}$ (tCO_2e/yr)
Year 1	0
Year 2	0
Year 3	0
Year 4	0
Year 5	0
Year 6	0
Year 7	0
Year 8	0
Year 9	0
Year 10	0

(d) *CO2 emissions from fossil fuels used for energy requirements.* Not considered for conservativeness. Business practice does not change before or after the project.

(e) *CO2 emissions from grid electricity consumption.* Not applicable. The mill produces its own electricity from renewable resources (biomass)

Ex-ante estimates of total baseline emissions for the project activity

Year	Baseline Emissions

	$BE_{CO2,TransEFB,y}$ (tCO_2e/yr)	$BE_{CH4,SW,y}$ (tCO_2e/yr)	$BE_{CH4,WW,y}$ (tCO_2e/yr)	Total Baseline Emissions (tCO2e/yr)
Year 1	0	4,500	16,586	21,086
Year 2	0	8,846	16,586	25,432
Year 3	0	13,042	16,586	29,628
Year 4	0	17,094	16,586	33,680
Year 5	0	21,006	16,586	37,592
Year 6	0	24,784	16,586	41,370
Year 7	0	28,432	16,586	45,018
Year 8	0	31,954	16,586	48,541
Year 9	0	35,356	16,586	51,942
Year 10	0	38,640	16,586	55,226
Total	0	223,654	165,861	389,515

Project emissions

The following types of project emissions will be accounted under this methodology:

(a) N_2O emissions from composting process
(b) CH_4 emissions from composting process
(c) CH_4 emissions from leaked waste water
(d) CO_2 emissions from transportation
(e) CO_2 emissions from fossil fuels consumption
(f) CO_2 emissions from grid electricity consumption

Diesel fuel used in front end loaders in the composting process and diesel fuel used for transport of EFB to the composting plant and for the transport of compost to spread as fertilizer on the plantation are accounted for under item (d). However, since the amount of diesel fuel used to transport the EFB to the landfill site in the baseline scenario is assumed to be negligible, then the amount used to transport EFB the much shorter distance to the compost plant is also assumed to be negligible. No other fossil fuels are used in the process and, therefore, item (e) is zero. All electricity generation for use in the mill and the composting process is from renewable fuels (waste products from the palm oil process) and hence item (f) is also zero.

Total project emissions are expressed as

$$PE_y = PE_{N2O,Comp,y} + PE_{CH4,Comp,y} + PE_{CH4,Bww,y} + PE_{CO2,Trans,y} + PE_{CO2,FF,y} + PE_{CO2,Elec,y}$$

$PE_{CO2,FF,y}$ *and* $PE_{CO2,Elec,y}$ **= 0**

(a) N_2O emissions from composting ($PE_{N2O,Comp,y}$):

N_2O emissions from composting during the year y are calculated as follows:

During the storage of waste in collection containers as part of the composting process itself and during the application of compost, N_2O emissions might occur. A default N_2O emission factor of 0.043 kg N_2O per tonne of compost and calculate emissions as follows:

$$PE_{N2O,Comp,y} = Q_{Compost,y} \cdot EF_{N2O,Comp} \cdot GWP_{N2O}$$

The quantity of compost produce each year = 12,075 tonnes

Parameter values used to calculate ex-ante project emissions for $PE_{N2O,Comp,y}$

Parameter	Value
$Q_{compost,y}$	12,075
$EF_{N2O,Comp}$	0.043
GWP_{N2O}	310

$PE_{N2O,Comp,y}$ = 12,075 * 0.043 * 310 / 1,000

$PE_{CH4, WW,y}$ = **161 tCO2e/yr**

Ex-ante estimates of project emissions for $PE_{N2O,Comp,y}$

Year	Project emissions $PE_{N2O,Comp,y}$ (tCO_2e/yr)
Year 1	161
Year 2	161
Year 3	161
Year 4	161
Year 5	161
Year 6	161
Year 7	161
Year 8	161
Year 9	161
Year 10	161

(b) *CH_4 emissions from composting ($PE_{CH4,Comp,y}$):*

During the composting process, aerobic conditions may not be completely reached in all areas at all times. Pockets of anaerobic conditions – isolated areas in the composting heap where oxygen concentrations are so low that the biodegradation process turns anaerobic – may occur. The emission behaviour of such pockets is comparable to the anaerobic situation in a landfill. This is a potential emission source for methane similar to anaerobic conditions which occur in unmanaged landfills. Through predetermined sampling procedures the percentage of waste that degrades under anaerobic conditions can be determined. Using this percentage, project methane emissions from composting process are calculated, as follows:

$$PE_{CH4,Comp,y} = PE_{CH4,Anaerobic,y} \cdot GWP_{CH4} \cdot S_{a,y}$$

Where:
$PE_{CH4,Anaerobic,y}$ is the quantity of methane that would be generated from anaerobic pockets in the composting process, during the year y (tCH_4)

GWP_{CH4} is the global warming potential of CH_4, default value 21

$\mathbf{S_{a,y}}$ Is the share of waste that degrades under anaerobic conditions in the composting plant during the year y (%). $\mathbf{S_{a,y} = S_{OD,y} / S_{total,y}}$ = Number of Samples with oxygen level <10% / Number of samples taken for oxygen measurement. $\mathbf{S_{OD,y}}$ **&** $\mathbf{S_{total,y}}$ will be determined as described in section B.7, Monitoring plan

The proposed tunnel composting process maintains a high concentration of oxygen by a very consistent and even distribution of airflow throughout the mass of composting waste. Hence it is expected that $S_{a,y}$ = 0.
Therefore:

$PE_{CH4,Comp,y}$ = **0**

(c) CH4 emissions from the leaked wastewater ($PE_{CH4,bww,y}$):

Projects such as composting will usually have no wastewater discharge but there is a possibility that a small quantity of leaked wastewater is collected from windrows or as a balance of waste water and this leak wastewater may cause CH_4 emissions.
CH_4 emissions from leak and/or balance of waste water shall be calculated as follows.

$$PE_{CH4,BWW,y} = COD_{outlet,total,y} \cdot B_o \cdot MCF_{outlet} \cdot GWP_{CH4}$$

However, in this project the proposed tunnel composting process collects all leachate and recycles it back to the process.

Therefore:
$PE_{CH4,BWW,y}$ = **0**

(d) CO2 emissions from transportation ($PE_{CO2,Trans,y}$):

The project emissions from transportation are to be calculated using the total distance and local, national or local version of IPCC Guidelines default values for transportation fuel, as follows:

$$PE_{CO2,Trans,y} = \sum_i N_{vehicles,i,y} \cdot Dist_{i,y} \cdot FC_i \cdot NCV_i \cdot EF_{CO2,i}$$

Transport fuel is used in the composting process as fuel for front end loaders and for the transport of compost to spread on the plantation as fertilizer.

<u>Fuel for front end loaders</u>
Number of front end loaders = 2
Yearly operating hours of front end loaders = 4 hours/day x 300 days = 1,200 hours
Diesel Fuel use per operating hr = 30x2 = 60 litres
Total yearly fuel use by front end loaders ($F_{compost,y}$) = 72,000 litres
NCV_i * $EF_{CO2,i}$ (kgCO2e/litre) = 2.672 (United States Environmental Protection Agency (“EPA”)

Then: $PE_{CO2,Trans,y\ I}$ = 72,000 * 2.672 / 1,000 = 192

Fuel required to transport compost to the plantation
Yearly amount of compost produced = 12,075 tonnes
Number of 5 tonne truck loads = 12,075 / 5 ~ 2,415 trips / yr
Average distance = 20 km
$FC_{i,TransEFB}$= 0.2 litre/km

$PE_{CO2,Trans,y\ II}$ = 2,415 * 20 * 0.2 * 2.672 / 1,000 = 26

Given: (i) the small size of this figure; (ii) that the project is not claiming credits from the avoidance of transportation of EFBs to the landfills or for the avoidance of chemical fertilizer transport; (iii) the difficulty to monitor these parameters; and (iv) the fact that the project plans to use the empty trucks returning to the plantations after unloading FFBs into the palm oil mills to deliver the project's fertilizer, these emissions are taken as zero.
Hence $PE_{CO2,Trans,y\ II}$ = 0

Parameter values used to calculate ex-ante project emissions for $PE_{CO2,Trans,y}$

$PE_{CO2,Trans,y}$ = 192 + 0 = 192 tCO2e/yr

Ex-ante estimates of project emissions for $PE_{CO2,Trans,y}$

Year	Project emissions $PE_{CO2,Trans,y}$ (tCO_2e/yr)
Year 1	192
Year 2	192
Year 3	192
Year 4	192
Year 5	192
Year 6	192
Year 7	192
Year 8	192
Year 9	192
Year 10	192

(e) CO2 emissions from fossil fuels used for energy requirements. Not applicable, business practice does not change before or after the project.

(f) CO2 emissions from grid electricity consumption. Not applicable. The mill produces its own electricity from renewable resources (biomass)

Ex-ante estimates of total project emissions for the project activity

Year	Total Project Emissions				
	$PE_{CO2,Trans,y}$ (tCO_2e/yr)	$PE_{CH4,BWW,y}$ (tCO2e/yr)	$PE_{CH4,Comp,y}$ (tCO2e/yr)	$PE_{N2O,Comp,y}$ (tCO_2e/yr)	Total Project Emissions

					(tCO2e/yr)
Year 1	192	0	0	161	353
Year 2	192	0	0	161	353
Year 3	192	0	0	161	353
Year 4	192	0	0	161	353
Year 5	192	0	0	161	353
Year 6	192	0	0	161	353
Year 7	192	0	0	161	353
Year 8	192	0	0	161	353
Year 9	192	0	0	161	353
Year 10	192	0	0	161	353
Total	1,923	0	0	1,610	3,533

Leakage

No leakage effects need to be accounted under this methodology.

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

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Emission reductions

Emission reductions are calculated as follows:

$$ER_y = BE_y - PE_y - LE_y$$

Ex-Ante Estimate of Emission Reductions for the project activity

Year	Estimation of baseline emissions (tCO2e)	Estimation of project activity emissions (tCO2e)	Estimation of leakage (tCO2e)	Estimation of emission reductions (tCO2e)
Year 1	21,086	353	0	20,733
Year 2	25,432	353	0	25,079
Year 3	29,628	353	0	29,275
Year 4	33,680	353	0	33,327
Year 5	37,592	353	0	37,239
Year 6	41,370	353	0	41,017
Year 7	45,018	353	0	44,665
Year 8	48,541	353	0	48,187
Year 9	51,942	353	0	51,588
Year 10	55,226	353	0	54,873
Total	389,515	3,533	0	385,982

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

B.7.1 Data and parameters monitored:

Data / Parameter:	$V_{POME,y}$
Data unit:	Cubic meter per yr
Description:	Yearly volume of wastewater pumped into the waste treatment plant's buffer tank.
Source of data to be used:	Continuously measured by Flow Meter at the water treatment plant buffer tank.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	147,000 m^3/year assuming 1 tonne of FFB generates 0.7 m^3 of POME as published by the Malaysian Department of Environment. Industrial Processes & The Environment. Handbook number 3. Crude Palm Oil Industry.
Description of measurement methods and procedures to be applied:	Flow Meter specified to the flowrate of POME and data recorded by PLC process computer.
QA/QC procedures to be applied:	The Flow Meter will undergo maintenance/calibration subject to appropriate industry standards. A back-up orifice plate will be installed in the POME pipeline for independent checks on the flowmeter calibration and in case of break down. Estimated accuracy of flowmeter +/- 3%.
Any comment:	$V_{POME,y}$ includes all waste water streams including wasterwater from the Steriliser, the Oil Clarification and the Hydrocyclone process.

Data / Parameter:	$COD_{influent}$
Data unit:	mg COD/litre
Description:	Annual weighted average COD concentration of the palm oil mill POME from all sources (before decanters)
Source of data to be used:	Sampling and analysis by standard methods
Value of data applied for the purpose of calculating expected emission reductions in section B.5	50,000 mg/l is the industry average as published by the Malaysian Department of Environment. Industrial Processes & The Environment. Handbook number 3. Crude Palm Oil Industry.
Description of measurement methods and procedures to be applied:	At least monthly manual sampling and analysis of the homogenized POME (including all sources) before the decanter.
QA/QC procedures to be applied:	Sampling according to nationally recognized procedures and analyses to be carried out by an accredited laboratory using standard QA/QC procedures to an accuracy of +/- 3%. These procedures will be specified in the certificates of analysis provided by the laboratory.
Any comment:	The decanter is included in the project boundary as all of the POME, including the decanter sludge, is treated in the composting process and subsequently any excess POME is treated in the aerobic treatment ponds, which are also within the project boundary.

Data / Parameter:	$COD_{effluent}$
Data unit:	mg COD/litre
Description:	COD of POME effluent after pre-treatment in the composting facility and final polishing treatment in the aerobic lagoons before discharge.

Source of data to be used:	Sampling and analysis by standard methods.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	100 mg/l
Description of measurement methods and procedures to be applied:	At least monthly manual sampling and analysis of the POME effluent discharge from the aerobic treatment ponds.
QA/QC procedures to be applied:	Sampling according to nationally recognized procedures and analyses to be carried out by an accredited laboratory using standard QA/QC procedures to an accuracy of +/- 3%. These procedures will be specified in the certificates of analysis provided by the laboratory.
Any comment:	A large percentage of the COD will be eliminated from the POME in the suspended solids removal treatment as a pre-treatment in the co-composting facility, while some 60% of the POME will be dissipated in the composting process. The remaining pre-treated POME will receive a final polishing treatment in aerobic lagoons prior to discharge.

Data / Parameter:	$A_{j,x}$
Data unit:	metric tonne (t)
Description:	The amount of EFB processed by the waste treatment plant
Source of data to be used:	Weight of FFB entering the mill on a daily basis with application of a standard 23% factor relating the amount of EFB produced to the quantity of FFB.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	48,300 t/year per plant (1 tonne of FFB produces 0.23 t of EFB)
Description of measurement methods and procedures to be applied:	The weight of FFB will be based on the measurement recorded by mill at their weighbridge as part of the mills inventory management.
QA/QC procedures to be applied:	Calibration and maintenance of weighing bridge subject to appropriate industry standards at an estimated accuracy of +/- 3%.
Any comment:	The Malaysian Department of Environment has published a process mass balance for Oil Palm mills in Malaysia which also applies to the Abedon mill. The reference is included in Annex 3 and shows that 0.23 tonne of EFB is produced for every tonne of FFB. All of the EFB will be processed in the composting plant on a daily basis for 365 days per year. The plant is designed to allow regular and periodic maintenance without having to shut down the process for any extended period.

Data / Parameter:	F_{cons}
Data unit:	Litres
Description:	Fuel consumption for equipment used in the composting process
Source of data to be used:	Purchase invoices for dedicated fuel depot at compost plant

Value of data applied for the purpose of calculating expected emission reductions in section B.5	72,000 litres/yr
Description of measurement methods and procedures to be applied:	Fuel consumed to be defined by billing figures from fuel suppliers with a high level of accuracy estimated at +/- 1%.
QA/QC procedures to be applied:	The amount of fuel will be derived from the paid fuel invoices with appropriate management auditing.
Any comment:	

Data / Parameter:	**$Q_{compost,y}$**
Data unit:	
Description:	Total quantity of compost produced in the year.
Source of data to be used:	Continual, daily records of production inventory, typically measured by standard 40kg bags or 1-tonne PP bulk bags.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	12,075 tonnes/yr (Assumes 75% volume reduction during composting process)
Description of measurement methods and procedures to be applied:	The measurement will be based on the measurements taken at the packaging/distribution plant
QA/QC procedures to be applied:	Scales at packaging/distribution plant to be regularly maintained and calibrated according to manufacturer's instructions with an estimated accuracy of +/- 3%.
Any comment:	

Data / Parameter:	**$S_{OD,y}$**
Data unit:	Number
Description:	Number of samples with oxygen level < 10%
Source of data to be used:	Oxygen sensor and transmitter
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0
Description of measurement methods and procedures to be applied:	n/a
QA/QC procedures to be applied:	Oxygen sensor and transmitter to be calibrated on a regular basis according to the manufacturer's instructions. Measurement itself to be continuous and automated by using PLC/SCADA process control system. A statistically significant sampling procedure will be set up that consists of multiple measurements throughout the different stages of the composting process

	according to a predetermined pattern (depths and scatter) on a daily basis. The data also will be used for control of the composting process. Estimated accuracy of oxygen analyser is +/- 2%.
Any comment:	

Data / Parameter:	$\mathbf{S_{total,y}}$
Data unit:	Number
Description:	Number of samples taken for oxygen measurement
Source of data to be used:	Oxygen sensor and transmitter
Value of data applied for the purpose of calculating expected emission reductions in section B.5	n/a
Description of measurement methods and procedures to be applied:	Total number of samples taken in year *y*, where $S_{total,y}$ should be chosen in a manner that ensures estimation of S_a with 20% uncertainty at 95% confidence level.
QA/QC procedures to be applied:	Oxygen sensor and transmitter to be calibrated on a regular basis according to the manufacturer's instructions. Measurement itself to be continuous and automated by PLC/SCADA process control system. A statistically significant sampling procedure will be set up that consists of multiple measurements throughout the different stages of the composting process according to a predetermined pattern (depths and scatter) on a daily basis. The data also will be used for control of the composting process.
Any comment:	

Data / Parameter:	$\mathbf{k_j}$
Data unit:	Factor
Description:	The decay rate for the waste stream type j – in this case EFB
Source of data to be used:	IPCC 2006 Guidelines for National Greenhouse Gas Inventories (adapted from Volume 5, Table 3.3)
Value of data applied for the purpose of calculating expected emission reductions in section B.5	The "Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site" recommends using as a default factor prior to adequate characterization of EFB the value corresponding to wood in the case of empty fruit bunches. **Waste Type** — **k_j (%) MAT>20°C MAP>1000 mm** Tropical — Wood, wood products and straw — 0.035 MAT for Sandakan is > 26^0 C (see Annex 3) MAP for Sandakan is 2078.5 mm (see Annex 3)
Description of measurement methods and procedures to be applied:	A method has been developed for measuring k_j for EFB as described in Appendix 1. This method will be used to provide an accurate measure of k_j prior to the end of the first verification period.
QA/QC procedures to	Incorporated into the test procedure and the standard methods of analysis that

be applied:	have been specified. QA/QC procedures of the accredited laboratory carrying out the tests will be provided with the test data
Any comment:	Due to the very high annual rainfall and temperature in this area of Malaysia and the highly biodegradable nature of EFB, the decay rate factor for EFB under anaerobic conditions in a landfill will be significantly higher than the value recommended for wood waste at MAT > 20^0 C and MAP > 1000 mm in the IPCC 2006 Guidelines. It is necessary, therefore, to carry out a test to accurately determine this value. The default value above as defined by IPCC would be used should the proposed tests prove not adequate to test the specific characteristics of this waste stream.

B.7.2 Description of the monitoring plan:

>>

MONITORING PLAN

1. Introduction

A special purpose vehicle (SPV) has been set up to own and operate the composting plant. The purpose of the Monitoring Plan (MP) is to provide a standard by which the SPV will conduct monitoring and verification of the proposed CDM project activity. The MP will be in accordance with all relevant rules and regulations of the CDM. The MP forms an integral part of this PDD and will facilitate accurate and consistent monitoring of the Project's Certified Emission Reductions (CERs). The SPV will use the MP for the duration of the project activity and will refine and expand it from time to time, as required. A CDM Management Unit has been established within the SPV organizational structure to manage the preparation and implementation phases of the proposed CDM project activity. During implementation it will be responsible for organizing and supervising all of the monitoring activities required for accurate and timely verification and reporting of the CERs generated.

2. Specific Objectives of the Monitoring Plan

Specifically, the objectives of the MP are the following:

- Establishing and maintaining a reliable and accurate monitoring system
- Provide guidance for the implementation of necessary measurement and record management operations
- Guidance for meeting CDM requirements for verification and certification

3. Operational and Monitoring Obligations

The MP will be supported by a CDM Operations and Monitoring Manual which will be prepared before the start of the first crediting period and will be tested during start up of the components of the project activity. This will provide an opportunity to correct any deficiencies and further refine the monitoring and recording procedures. It will also provide an opportunity to train laboratory and operating personnel in the strict requirements for accuracy in collecting and recording data for CDM purposes.

4. 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 activity and include the operation and management of the monitoring and record keeping system that is described in the MP.

The first line of responsibility for implementing the MP will be the Board and Managing Director of the SPV. The CDM coordinator reports directly to the Managing Director. The coordinator's primary responsibility is to ensure that all monitoring and data recording for the project activity meet the requirements for CER verification and certification. This will involve:

- The establishment of transparent systems for the collection, computation and storage of data, including adequate record keeping and data monitoring systems.
- Setting internal auditing procedures for data verification consistent with CDM requirements
- Setting up a regular reporting system meeting internal and external requirements
- Establishing quality control procedures for all monitorable parameters
- Evaluating training needs and carrying out training programs

- Monitoring and reviewing safety and environmental aspects of the CDM operations
- Community and stakeholder consultation.

The monitoring requirements for the project activity are described in detail in Annex 4 and are not repeated here.

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

>>
Date of completion: 8/06/2007

Person/entity determining the baseline:

Climate Change Capital Ltd. acting on behalf of Climate Change Capital Carbon Fund II S.a.r.l
3 More London Riverside, London, SE1 2AQ

Javier Rojo
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Tel: +44 (0)20 7939 5229
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Climate Change Capital Carbon Fund II S.à r.l is the Project CDM investor and also a Project Participant

SECTION C. Duration of the project activity / crediting period

C.1 Duration of the project activity:

C.1.1. Starting date of the project activity:

>>
07/12/2006 is the date that marks the formation of project team and the date when the project participants started to consider the implementation of the proposed technology.
Physical implementation of the project activity is expected to start in May 2008 with the preparation of a tender process for the construction of the required facilities. Construction works are expected to be completed in September 2008 and the start of operations is expected by October 2008.

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

>>
10 years

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

C.2.1. Renewable crediting period

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

>>
N/A

C.2.1.2. Length of the first crediting period:

>>
N/A

C.2.2. Fixed crediting period:

C.2.2.1. Starting date:

>>
01/10/2008 (Expected)

C.2.2.2. Length:

>>
10 years

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. The project activity will provide the following environment benefits:

- Reduction of methane and other odorous emissions from the EFB landfill and the anaerobic POME lagoons
- Control of odours in the tunnel composting process with treatment of any air emissions through a compost bio-filter
- No leachate emissions from the tunnel composting process as all leachate is collected a recycled to the process
- Recycling of waste back to the plantation as an enriched compost
- Reduced use of chemical fertilisers
- Improve soil conditions in the oil palm plantation
- Prevent BSR disease in the oil palm plantation
- Prevent leachate runoff into streams from EFB landfill

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:

>>
Environmental impacts of the process are negligible, while the environmental benefits are substantial.

SECTION E. Stakeholders' comments

>>

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

>>

A public forum was organized in conjunction with the requirement for a consultation of local stakeholders in the design for the CDM Project on waste recycling through integrated waste management at Abedon Oil Mill, Kinabatangan, Sabah. The public forum was held at the Sabah Hotel, Sandakan on 9th May from 9.00 a.m. to 12.00 noon.

The potential stakeholders were identified, including government, industry and business, non-government organisations (NGOs), academia, civil society and the media. Invitations were sent directly to more than 50 potential stakeholders about 3 weeks before the date of the forum. In addition, an advertisement, announcing the public forum, was placed in a local newspaper, the Daily Express.

A total of 47 participants attended the public forum. A brief introduction was given by the Chairman, Mr. Shen Lim of Inno Integrasi, before presentations as follows:

- The Clean Development Mechanism - Javier Rojo of Climate Change Capital,
- The background of the Palm Oil Industry, waste management, bio-products generated from integrated waste management, and the proposed project at Abedon Oil Mill - Shen Lim of Inno Integrasi
- The technology of the EcoRegen system for integrated waste management at the palm oil mill - Mr. Khai Yip Mun of EcoRegen

E.2. Summary of the comments received:

>>

Comments and questions received covered issues such as project sustainability, approval from the Department of Environment, resource depletion, discharges/emissions into the environment, economic benefits to the industry, impact to the local community and clarification of the relevance of CDM. These comments are questions are detailed in the following section E.3.

Following the Q&A the Chairman thanked the participants, and informed that the relevant issues and concerns raised would be taken into account for the finalizing of the PDD and the full PDD would be posted on the website by the Project Validator, SGS, for 30 days on completion of the validation report, for comments and feedback from all interested stakeholders.

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

>>

Question/Comment	Response
1. Is the technology approved by the Department of Environment (DOE)?	EcoRegen has met and presented to the DOE Sabah and received an encouraging response. The application submission process for approval of the technology for Abedon Oil Mill is currently in progress.
2. How sustainable is the project in terms of energy consumption – will more fossil fuel be required to operate the technology?	In Abedon there is excess power capacity from renewable sources in the current operation that can be used by the waste treatment system, which is far in excess of the level of power required by the waste treatment plant.
3. How does CDM apply to this project?	The project activities qualify for CDM through avoiding the release of methane emissions. In the business as usual scenario methane is released through the anaerobic degradation of both the solid and liquid wastes.
4. This project does not result in zero-discharge.	This process does not result in zero-discharge, but does treat 100% of the waste from the palm oil mill and reduces leachate to zero. The fertilizer is produced from 60% of the POME volume, 100% of the EFB and solids removed from the remaining 40% of the POME. The residual water from the 40% POME has significantly reduced COD following the removal of suspended solids and is finally treated aerobically.
5. During high season of production, there is excess power available for the waste treatment plant, but during low production season, will the project have to resort to fossil fuel for energy?	The waste treatment plant does need a limited amount of power to operate at night. During high season the power requirement of the waste treatment plant can be met fully by normal operation of the palm oil mill. During low season the waste treatment plant will require power supply at times when the palm oil mill will not be operational. At these times the existing renewable energy supply will still be more than adequate to cover requirement. However, in the event that back-up power from diesel is required, then the diesel usage will be included in the project emissions calculation.
6. Does the project meet Malaysia’s policy on sustainable development?	Yes, in the 3 areas of environmental, social and economic sustainability. These are attained through treating 100% of the wastes, creating new and skilled jobs and producing bio-organic fertilisers.
7. What is the impact on the local community, especially on the communities downstream of the project.	Job creation and more opportunities for developing and transfer of skills. Pest reduction due to removal of wastes will benefit the local communities.
8. Apart from using it internally can the owner sell the bio-organic fertiliser to the open market?	There is an economic value for the bio-organic fertiliser and selling it to the open market could be an option.
9. What is the economic benefit of such a project to business in term of investment costs and returns?	This would vary on a case-to-case basis and should be discussed on a one-to-one-basis.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

Organization:	Climate Change Capital acting on behalf of Climate Change Capital Carbon Fund II S.à r.l
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Represented by:	
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Annex 2

INFORMATION REGARDING PUBLIC FUNDING

NO PUBLIC FUNDING IS INVOLVED IN THIS PROJECT

Annex 3

BASELINE INFORMATION

Monthly Temperature and Rainfall averages for Sandakan			
January	Avg Low: **24°C**	Avg Hi: **29°C**	Avg Precip: **215.6 mm**
February	Avg Low: **24°C**	Avg Hi: **30°C**	Avg Precip: **187.9 mm**
March	Avg Low: **24°C**	Avg Hi: **31°C**	Avg Precip: **121.3 mm**
April	Avg Low: **25°C**	Avg Hi: **32°C**	Avg Precip: **61.8 mm**
May	Avg Low: **25°C**	Avg Hi: **32°C**	Avg Precip: **92.5 mm**
June	Avg Low: **24°C**	Avg Hi: **32°C**	Avg Precip: **135.6 mm**
July	Avg Low: **24°C**	Avg Hi: **32°C**	Avg Precip: **147.7 mm**
August	Avg Low: **24°C**	Avg Hi: **32°C**	Avg Precip: **149 mm**
September	Avg Low: **24°C**	Avg Hi: **32°C**	Avg Precip: **188.8 mm**
October	Avg Low: **24°C**	Avg Hi: **31°CV**	Avg Precip: **231.5 mm**
November	Avg Low: **24°C**	Avg Hi: **31°C**	Avg Precip: **231.5 mm**
December	Avg Low: **24°C**	Avg Hi: **30°C**	Avg Precip: **315.3 mm**

Total Annual Average Rainfall for Sandakan = 2,078.5 mm

Malaysian Palm Oil Mill Process Mass Balance (Source: Malaysian Department of Environment. Industrial Processes & The Environment. Handbook number 3. Crude Palm Oil Industry. 1999)

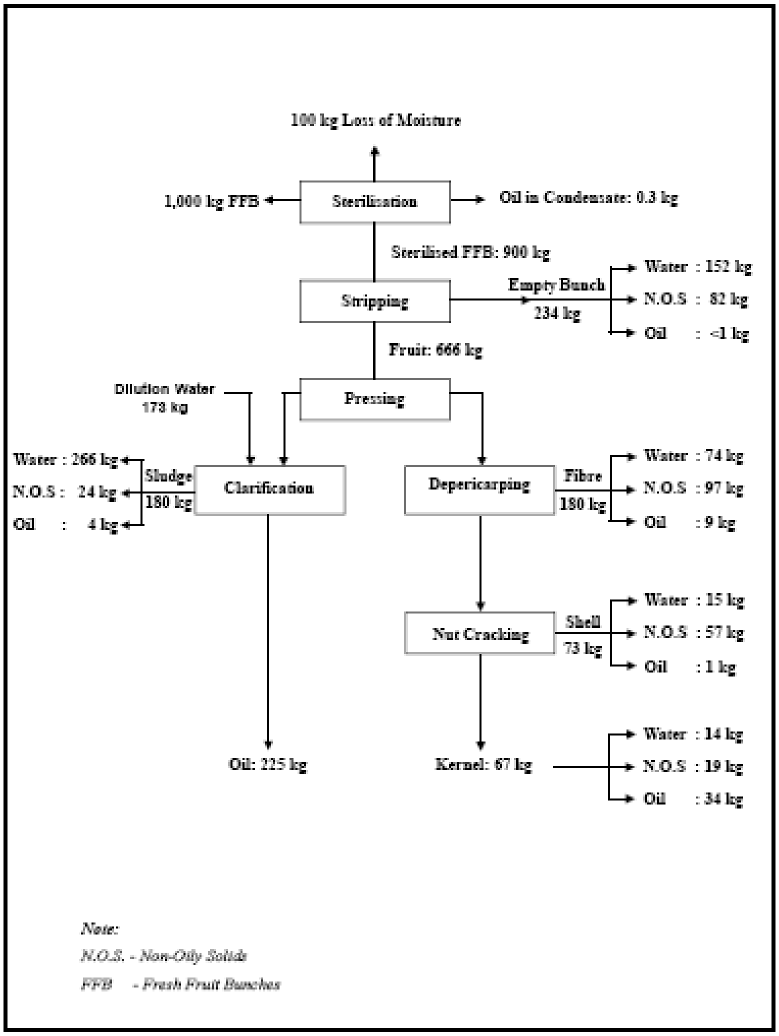


Figure 5 : Typical Mass Balance for Mill Processing of Palm Fruit

Annex 4

MONITORING PLAN

This Monitoring Plan details the actions necessary to record all the monitoring parameters required by AM0039 – version 2, which are detailed in section B.7.1 above. All data will be archived electronically, and backed up regularly. The data will be kept for the full crediting period, plus two years after the end of the crediting period, or the last issuance of CERs for this project activity, whichever occurs later. The Monitoring Plan for this project has been developed to ensure that from the start, the project is well organized in terms of the collection and archiving of complete and reliable data. The details of the monitoring management and organization are provided in Section B.7.2.

1. Continuous monitoring equipment and calibration requirements

The amount of solid waste (EFB) and wastewater (POME) treated, the amount of compost produced and sampling of oxygen levels in the composting waste will be the main monitoring parameters requiring continuous monitoring equipment for CDM verification purposes in the Abedon palm-oil mill. It is well established in the Malaysian palm oil industry that the percentage of EFB produced from FFB is 23%. Since all of the EFB will be utilized in the co-composting process, it is more convenient to measure the amount of FFB than EFB and apply this factor to determine the amount of EFB.

(a) Metering of FFB and compost using the existing Abedon weighbridge

The main weighbridge for measuring the amount of FFB delivered to the composting facility is already in operation at the Abedon palm-oil mill. This weighbridge measures the quantity of raw material FFB input to the palm-oil mill and is installed at the main gate. The weighbridge is already subject to comprehensive accuracy and calibration checks according to standard industry practice as it is the key measurement parameter used to pay plantation owners for the supply of FFB. It is also one of the key measurement parameters for the CDM verification process. If this weighbridge breaks down for any reason the mill would have to find an alternative method to accurately account for FFB input or shut down until it is repaired and recalibrated. Hence there is no time during the processing of FFB and the production of EFB when this machinery is not in operation. The weighbridge will also be used to measure the amount of compost produced. Since the compost will be sold to the nearby plantations, this record is important for customer billing purposes as well as for CDM verification and equally important that the weighbridge is accurately and regularly calibrated for both purposes. Records of the weighbridge type, make, model and calibration documentation will be retained in the quality control system.

(b) Metering of POME using wastewater flow meter

From the existing wastewater exit point in the Abedon palm-oil mill, instead of discharging into the first anaerobic lagoon, a pipe will be connected with a wastewater pump and flow meter to deliver POME to the co-composting facility. The flow meter will continuously measure the total flow of POME and will electronically record these data. The data will be compiled to record daily flows of POME. The flow meter will be installed to meet all the manufacturer's specifications and calibrated at regular intervals as specified by the manufacturer. Records of the meter type, make, model and calibration documentation will be retained in the quality control system. In case of flow meter failure and as an independent calibration check an orifice plate will be installed in a straight section of the POME pipeline with appropriate pressure tappings as a back-up means of measuring flow rate of POME. Regular manual monitoring of POME flow rate using the orifice plate and water gauge manometer will be undertaken in the event of POME flow meter failure.

(c) Metering of Oxygen levels in the composting process

Unlike windrow composting in-vessel composting relies on continuous measurements of oxygen levels from several monitoring points throughout the composting vessel. Moreover, to ensure the most rapid rate of composting the oxygen levels are maintained at even higher levels than windrow composting. Hence there will be an extensive electronic record of oxygen levels for each composting vessel and each batch of compost that is produced. These will be analyzed automatically for each batch to determine with a high level of accuracy the percentage of oxygen concentration readings that fall below 10%. The oxygen probes will be calibrated according to the instructions of the manufacturer at a frequency that will ensure a continuously high level of accuracy. Extra probes will be kept as spares and pre-calibrated to provide back-ups in case of probe failures. Records of the meter type, make, model and calibration documentation will be retained in the quality control system.

2. Sampling and analysis of POME influent and effluent

The only sampling and analysis of waste streams that is required under this methodology is the COD of POME and of the waste water discharge after the aerobic treatment of the residual pre-treated POME. Representative samples of the POME (taken from the well mixed waste stream before the decanter) and effluent from the waste water treatment plant will be produced from a composite of hourly samples taken over a 24 hr period. This sampling will be repeated at monthly intervals and sent to a nationally accredited laboratory for analysis of COD using a standard method approved by Malaysia's Ministry of Environment. The QA/QC procedures followed by the laboratory will be detailed and provided with the certificates of analysis to ensure an analytical accuracy of +/- 3%.

3. Monitoring of fuel usage in the composting process

A dedicated diesel fuel storage depot at the composting plant will supply fuel for the front end loaders and trucks other equipment used in the composting process. Invoices will be kept for purchases of diesel fuel supplied to this depot as a record of fuel use. Monthly readings of fuel storage in the depot (from level gauges or depth measurements in the fuel tank) and quantities of fuel purchased will be analyzed to accurately record monthly fuel use to an accuracy of +/- 1%. Calibration records of liquid levels in the fuel tank will be kept for confirmation of the CDM verifiers.

4. Data and records management

All data collected during the verification period will be stored in an electronic format that will be easily accessible to the CDM verifier for independent checking. In the event that a series of measurements is truncated a remediation of conservative interpolations with recorded data will be applied to restore the integrity of the data. In order to make it easy for the verifier to retrieve the documentation and information in relation to the project emission reduction verification, a document register will be maintained and continually up-dated. The document register will ensure adequate document control for CDM purposes.

The dedicated CDM Manager will be responsible for checking the data (according to a formal procedure) and will be responsible for managing the collection, storage and archiving of all data and records. A procedure will be developed to manage the CDM record keeping arrangements. All the data will be kept for two years after the end of each credit period.

5. Summary of Quality Control (QC) and Quality Assurance (QA) measures

As noted above and in Section B.7.1 all measurements will use calibrated measurement equipment that is maintained regularly and checked for its functioning. A summary of QA/QC procedures for the parameters to be monitored are given in the following table.

Data	Uncertainty Level of Data (Low, Medium, High)	Explain QA/QC procedures planned for these data, or why such procedures are not necessary
$V_{POME,y}$	Low	The POME flow meter will undergo maintenance/calibration subject to appropriate industry standards. A back-up orifice plate will be installed in the POME pipeline for independent checks on the flow meter calibration and in case of flow meter break down.
$COD_{influent}$	Low	Sampling according to nationally recognized procedures and analyses to be carried out by an accredited laboratory using standard QA/QC procedures. These procedures will be specified in the certificates of analysis provided by the laboratory.
$COD_{effluent}$	Low	Sampling according to nationally recognized procedures and analyses to be carried out by an accredited laboratory using standard QA/QC procedures. These procedures will be specified in the certificates of analysis provided by the laboratory.
$A_{j,x}$	Low	Calibration and maintenance of weighing bridge subject to appropriate industry standards
F_{cons}	Low	The amount of fuel will be derived from the paid fuel invoices with appropriate management auditing.
$Q_{compost,y}$	Low	Calibration and maintenance of weighing bridge subject to appropriate industry standards
$S_{OD,y}$ and $S_{total,y}$	Low	Oxygen sensor and transmitter to be calibrated on a regular basis according to the manufacturer's instructions. Measurement itself to be continuous and automated by using PLC/SCADA process control system. A statistically significant sampling procedure will be set up that consists of multiple measurements throughout the different stages of the composting process according to a predetermined pattern (depths and scatter) on a daily basis. The data also will be used for control of the composting process
k_j	Medium	Incorporated into the test procedure and the standard methods of analysis that have been specified. QA/QC procedures of the accredited laboratory carrying out the tests will be provided with the test data

Annex 5

Malaysian National CDM Criteria

National CDM Criteria

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

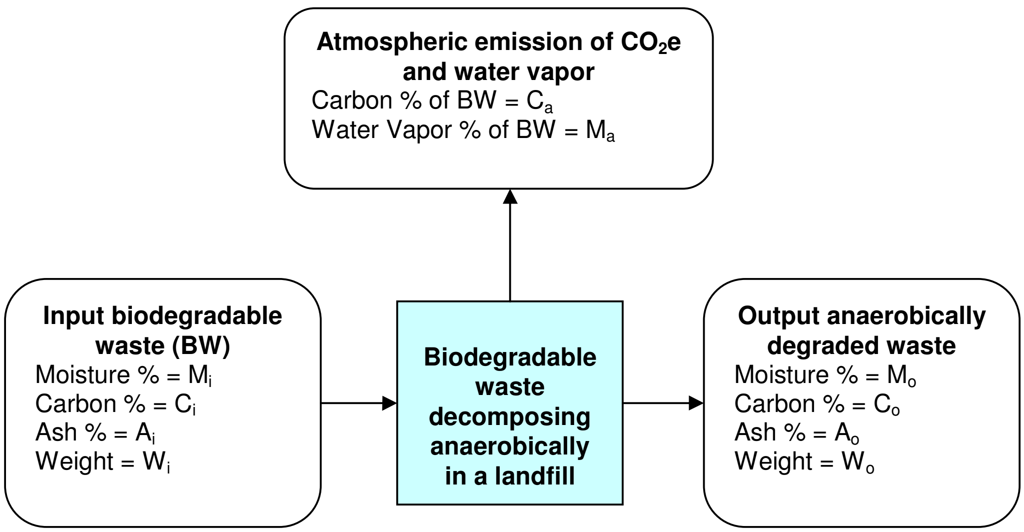
The project must support the sustainable development policies of Malaysia and bring direct benefits towards achieving sustainable development;	The proposed project addressed the sustainability of palm oil industry by improving the environmental impact of the supply chain. This project brings advantages to the palm oil industry in particular and to Malaysia as a whole as more consumers are demanding for sustainable food production. The proposed project is in support of the government efforts in developing and promoting the utilisation of environmental friendly and sustainable waste treatment. 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 Inno Integrasi Sdn Bhd and Climate Change Capital Carbon Fund II S.à r.l. The Annex 1 party involved in the project is Climate Change Capital Carbon Fund II S.à r.l.
Project must provide technology transfer and/or improvement in technology;	The project has licensed the proprietary bio-technology to provide for technology and expertise on the manufacturing of the bio-organic fertilisers. The in-vessel co-composting technology is new to Malaysia and new to the palm oil industry. The project will be importing design and engineering technology and expertise from Australia, which reduces the environmental footprint of the composting process, whilst increasing the quality of the compost product.
Project must fulfil all conditions underlined by the CDM Executive Board;	The project activity would be developed according to the CDM Approved Methodology AM0039 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 Inno Integrasi Sdn Bhd and Climate Change Capital Carbon Fund II S.à r.l will jointly contribute to the cost of implementing the project activity bringing additional technical and technological support where required.
Giving due importance to environmental considerations	The project will reduce the emission of green house gases from the palm oil mill, particularly methane from EFB landfill and wastewater treatment ponds. The project will be implemented to comply with all applicable environmental regulations in the Malaysia

Appendix 1

ANALYTICAL METHOD FOR ESTIMATING DECAY FACTOR “k”

Analytical method for estimating methane emissions from landfills and hence for estimating the decay factor “k”

Organic waste breaks down anaerobically in a landfill to produce methane and carbon dioxide. This process can be mathematically simulated by carrying out an ash and carbon balance as indicted in the diagram below, where for convenience the methane and carbon dioxide emission is represented by the amount of CO_2 equivalent.



Since the quantity of ash is unchanged in the process:

$W_i * A_i = W_o * A_o$

Since some of the carbon in the input biodegradable waste is converted to CO_2 and methane in the anaerobic process, a mass balance on carbon gives the following equation:

$C_a * W_i = C_i * W_i - W_o * C_o$[2]

Combining these two equations:

$C_a = C_i - (A_i/A_o) * C_o$

---

[2] Note that C and A are on a wet weight basis

This can be converted into CO_2 equivalent emission as a percent of input biodegradable waste by the following equation:

$CE_a = (44/12) * (C_i – (A_i/A_o) * C_o)$

Where, CE_a is the amount of CO_2 equivalent emission from the anaerobic process as a percent of input wet biodegradable waste. Alternatively this equation can be expressed as follows:

$CE = (44/12) * (C_i – (A_i/A_o) * C_o) * (1000/100)$ --------------------------- (Equation 1)

Where, CE is the kg of CO_2 equivalent emission per tonne input waste.

If the waste had degraded under anaerobic conditions in a landfill the biodegradable carbon would have been converted into 50% by volume of methane and 50% by volume of CO_2, instead of 100% CO_2 as in aerobic composting process.

In the anaerobic process in the landfill:

2 moles of biodegradable C → p moles of CH_4 + (2-p) moles of CO_2

Therefore:

24 kg of biodegradable C → p * 16 kg of CH_4 + (2-p) * 44 kg of CO_2

24 kg of biodegradable C → $(p * 16/d_{CH4})$ m^3 of CH_4 + $((2-p) * 44/d_{CO2})$ m^3 of CO_2

Where d_{CO2} is the density of CO_2 at 15^o C and 1.013 bar = 1.87 kg/m^3
Where d_{CH4} is the density of CH_4 at 15^o C and 1.013 bar = 0.688 kg/m^3

Therefore, if there is a 50:50 mixture of CH_4 and CO_2 in the LFG, then:

$(p * 16 / d_{CH4})$ m^3 of CH_4 = $((2-p) * 44 \text{ kg} / d_{CO2})$ m^3 of CO_2

Hence: p = 1.0

Therefore in an anaerobic landfill process:

24 kg of biodegradable C → 16 kg of CH_4 + 44 kg of CO_2

Expressing the equation in terms of CO_2 equivalent gives:

2 moles of biodegradable C → 2 moles of CO_2

Therefore:

24 kg of biodegradable C → 88 kg of CO_2 equivalent

It follows, therefore, that 88 kg of CO_2 equivalent represents 16 kg of CH_4 produced anaerobically in a managed landfill from the same amount of biodegradable C , since in the anaerobic process 44 kg of CO_2 is also produced.

Applying this factor to Equation 1 gives:

$Lo_y = (440/12000) * (C_i – (A_i/A_o) * C_o) * (16/88)$

$= 0.00667 * (C_i – (A_i/A_o) * C_o)$

Where:

Lo_y tonne of methane generated under anaerobic conditions in a landfill / tonne waste treated

Applying the IPCC correction factor of MCF for unmanaged landfills gives:

$Lo_y = 0.00667 * MCF * (C_i – (A_i/A_o) * C_o)$ --------------------- (Equation 2)

Outline of a laboratory method to determine the methane decay rate factor "k" for any waste material under anaerobic conditions in a landfill

A test method along the lines of the Uganda MSW Decay Rate Study (a copy of which will be provided to the DOE for validation) will be carried out on Oil Palm EFB. The EFB will be shredded and compacted into the containers to a density of approximately $400kg/m^3$. The shredded EFB will be analysed for moisture, ash and total carbon according to ASTM methods listed below. The containers will be loaded with a bottom layer of coarse sand to 2 cm thickness and then the waste material and sealed as described in the attached reference with temperature and pressure sensors and placed in a container at a controlled temperature of 35^0C (if possible, otherwise at room temperature with insulation wrapped around the containers to minimize heat loss). Eight bins will be loaded with shredded EFB. The bins will be opened and analysed for moisture, ash and total carbon according to the following schedule: week 2, 4, 6, 8, 10, 12, 24 and 48 weeks. The amount of methane generated during each time period is determined by Equation 2. Temperature and pressure in each container is recorded daily. The relevant ASTM Standards of analysis are as follows (equivalent standards can be used):

ASTM E 1757-01: Standard Practice for Preparation of Biomass for Compositional Analysis

ASTM D 2974-99: Standard Test methods for Moisture, Ash and Organic Matter of Peat and other Organic Soils

ASTM D 5373-02: Standard Test Methods for Instrumental Determination of Carbon, Hydrogen and Nitrogen in Laboratory Samples of Coal and Coke