Clean Development Mechanism

Project Design Document
For

Forced Methane Extraction from Palm Oil Mill Effluent
at
Bell Palm Industry Sdn. Bhd., Johor, Malaysia

Prepared by

Sanwa Engineering Co., Ltd. (Japan)

Supported by

Technova Inc. (Japan)

and

Novaviro Technology Sdn. Bhd. (Malaysia)

March 2006

CLEAN DEVELOPMENT MECHANISM
PROJECT DESIGN DOCUMENT FORM (CDM-PDD)
Version 02 - in effect as of: 1 July 2004)

CONTENTS

SECTION A. General description of project activity

A.1 Title of the project activity:

"Forced Methane Extraction from Palm Oil Mill Effluent at Bell Palm Industry Sdn. Bhd., Johor. Malaysia"
Version 01
Date: 10 Feb. 2006: Initial Adoption

A.2. Description of the project activity:

1) The purpose of the project:

The purpose of the project is to replace the existing waste-water treatment system for palm oil mill effluent (POME) treatment at the palm oil mill of Bell Palm Industries Sdn. Bhd., which was based on traditional open lagoon anaerobic digestion with uncontrolled release of methane to the atmosphere. with a closed anaerobic tank digestion system, of which the biogas produced will be recovered and utilised for heat generation. The project will contribute to an economically, environmentally and socially sustainable development of the palm oil industry in Malaysia.

2) Contribution to Sustainable Development:

The project contributes significantly to sustainable development and these are described as follows:

- Utilizing Palm Oil Mill Waste for Renewable Energy

  Malaysia is currently the largest producer and exporter of palm oil in the world, with 60% of the country's cultivated land is attributed to oil palm plantation. There are more than 380 palm oil mills which produced a total of 14 million tons of crude palm oil (CPO) from the processing of 69.5 million tons of fresh fruit bunches (FFB) for the year of 2004. Accompanying the CPO production process. the following residues are generated concurrently: 16 million tons of empty fruit bunches (EFB). 8.3 million tons of palm fiber, and 4.9 million tons of palm shell, and 41.9 million tons of POME.

  Palm oil industry waste, including mesocarp fibres, palm kernel shells and empty fruit bunches (EFB), as well as palm oil mill effluent (POME), represents the biggest potential for biomass energy utilisation in the country, in as much as these are easily available and are presently requiring cost effective means of disposal. The following table shows that palm oil industry accounts for the largest biomass waste production in Malaysia.

Table 1. Biomass Resources Potential of Malaysia (1999)*

Sector	Quantity (Kton/yr)	Potential Annual Generation (GWh)	Potential Capacity (MW)
Rice Mills	424	263	30
Wood Industry	2,177	598	68
Bagasse	300	218	25
Palm Oil Mills	17.980	3.197	365

POME	31,500	1.587	177
TOTAL	72.962	5,863	665

**From UNDP/GEF project document entitled: "Biomass-based Power Generation and Co-generation in the Malaysian Palm Oil Industry – Phase I", February 2002.*

Depending on the extent the EFBs are used as fuel and whether POME-derived biogas is also used or not, the potential power generation capacity from the palm oil industry by year 2005 would range from 270 MW, if only all of the mesocarp fibers and shells are used, up to 542 MW, if all palm oil mill residues are utilised. A total recovery of POME biogas is estimated to contribute to a potential power generation capacity of 177 MW.

- Improvement of POME treatment and pollution control

Regulatory control on the treatment and discharge of effluents from palm oil mills is under the Environmental Quality Act (EQA) 1974 and the Environmental Quality Regulations 1977 therein. The regulations specified the limits for the following key parameters, including BOD, pH, temperature, suspended solids, oil and grease, ammoniacal nitrogen, and total nitrogen in the final discharge, which is permitted to be discharge to open water course. EQA 1974 and the relevant regulations do not specify any control on the emission of methane and other gaseous species from wastewater treatment plants and processes.

To ensure the palm oil mill effluent (POME) is adequately treated, The common treatment method currently adopted by most of the palm oil mills to meet the regulatory requirements before discharging to the watercourse is the open lagoon anaerobic digestion system, followed by facultative and aerobic treatment, also in open lagoons. However, the present method of treatment suffers the following drawbacks:

- Biogas generated from the open lagoon system gives rise to bad odour; complaints from the public have been raised in various cases.
- The treatment system will occupy relatively large land area, ranging from more than 5 to 20 hectares.
- The open lagoon treatment methods are generally of low efficiency, leading to sludge built-up and problems of effluent quality unable to comply with the regulatory control limits.
- Methane emitted from the conventional waste water treatment is a potent greenhouse gas contributing to global warming.

The closed-tank anaerobic digestion method proposed will overcome the above-mentioned drawbacks of the common treatment method currently adopted by most of the palm oil mills.

- Reducing the GHG emissions

It is estimated that the with the output of 42 million tons of POME projected from the palm oil industry for 2004, a total of 525,000 tons of methane is expected to be generated from the anaerobic decomposition of the POME. With the closed-tank anaerobic digester system adopted for POME treatment, most of the methane originally emitted to the environment from open lagoons for anaerobic treatment of POME will be avoided.

The following is a summary of the benefits of the closed-tank anaerobic digester system for POME treatment and methane recovery:

To the industry:

- The biogas produced can be used as a fuel for heat and/or power generation.
- Saving in fossil fuel consumption in the palm oil mill and/or the complex can be realised.

To the surrounding community

- The nuisance of bad odours from the open lagoon anaerobic system will be avoided.
- Improvement in the water quality of vicinity water course receiving discharge from the mill is expected due to improvement in efficiency of wastewater treatment with the use of closed CSTR anaerobic digester system in place of the existing open lagoon anaerobic system.

To the environment

- The new anaerobic digester system with biogas capture will reduce the emission of methane, a potent global warming greenhouse gas.
- Combustion using biogas for heat and/or power generation will reduce dust emissions and air pollution.
- Improvement in water and air quality as well as human health is expected.

To the country

- The project will enhance the efforts in environmental protection.
- The use of biogas for heat and/or power generation contributes to reduction of imports of fossil fuel.
- The project demonstrates the effective utilization of waste as a resource through the adoption of new and appropriate technology.

A.3. Project participants:

Name of Party involved (*) ((host) indicates a host Party)	Private and/or public entity (ies) project participants (*) (as applicable)	Kindly indicate if the Party involved wishes to be considered as project participant (Yes/No)
Japan	Private entity: Sanwa Engineering Co., Ltd., Japan	No
Malaysia (host)	Private entity: Bell Palm Industries Sdn Bhd, Malaysia	No

Japan has ratified the Kyoto Protocol on 4 July 2002.
Malaysia has ratified the Kyoto Protocol on 4 September 2002.

A.4. Technical description of the project activity:

A.4.1. Location of the project activity:

The project activity is located in the southern region of the west coast of Peninsular Malaysia, approximately 20 km from Batu Pahat town of the state of Johor and 250 km south of Kuala Lumpur, the national capital.

A.4.1.1. Host Party(ies):

Malaysia

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

Johor Darul Takzim

A.4.1.3. City/Town/Community etc:

83000 Batu Pahat, Simpang Kiri, Lot 4960 Parit Ju

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

The palm oil mill of Bell Palm Industries (BPI) was built in the late 1970s for the production of crude palm oil from oil palm fresh fruit bunches (FFB). The Bell Group of Malaysia bought over the mill in 1986, which was then named Bell Prisawit Sdn Bhd then. The company name has been changed to Bell Palm Industries Sdn Bhd in 2005. The mill has been expanded from a capacity of 20 tons FFB/h to 40 tons FFB/h in 2002.

Project Site:
Bell Palm Industries Sdn Bhd
Lot 4960 Parit Ju, Simpang Kiri
83000 Batu Pahat, Johor Darul Takzim
MALAYSIA

As shown in the above maps, BPI is located in the district of Batu Pahat, approximately 20 km to the north of the district town of Batu Pahat, state of Johor in the southern part of Peninsular Malaysia. The site is approximately 250 km from Kuala Lumpur, the capital of Malaysia. The proposed project will be located within the existing area of BPI, and hence no additional land space is required.

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

The project activity may be classified under Category 13: "Waste handling and disposal" listed in the sectoral scopes for accreditation of the operational entities (http://cdm.unfccc.int/DOE/scopes.html).

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

Conventional and common POME treatment technology in Malaysia

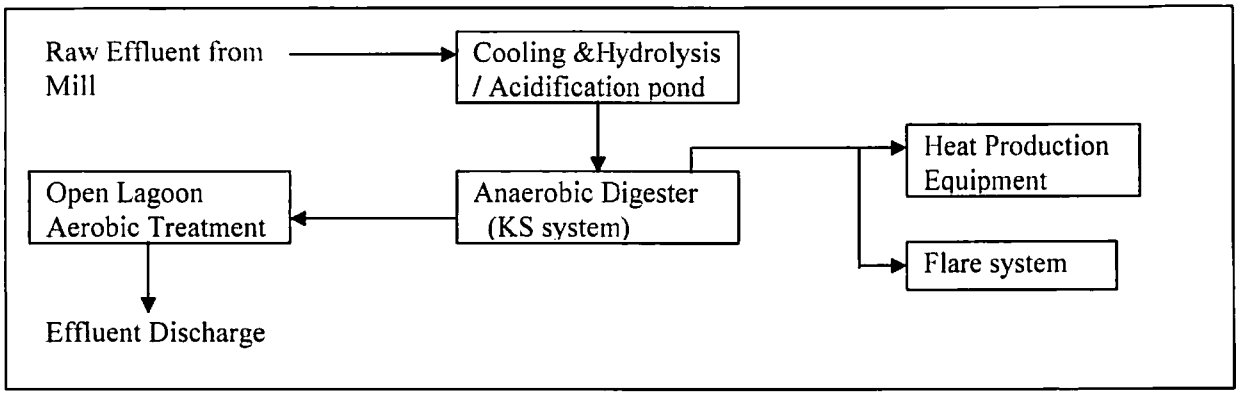
POME is generated during palm oil production processes at a rate of about 0.6 m^3/t of oil palm fresh fruit bunches (FFB). A palm oil mill of 40 t FFB/h will process about 240,000 t FFB and a total of 144,000 m^3 of POME will be generated per annum. POME is characterised by the very high organic matter contents derived from the organic fractions of the palm oil production process with an average BOD and COD level of 30,000 and 645,000 mg/L, respectively. POME is ranked among the strongest industrial wastewater in terms of organic matter contents in the world, and the most significant because of its large volume generated from the palm oil industry.

The existing wastewater treatment system at BPI is based on the most common treatment method adopted by the palm oil industry in Malaysia, which involves the application of deep open lagoons for anaerobic digestion of the POME, followed by shallow open lagoons for aerobic treatment to further reduce the organic pollutants to an acceptable concentration level before discharging to the river. The open lagoon anaerobic digestion will reduce the COD level from 64,500 mg/L to less than 10,000 mg/L and BOD from 30,000 mg/L to less than 500 mg/L, with the production of biogas comprising mainly methane (CH_4) and carbon dioxide (CO_2), and traces of hydrogen sulphide (H_2S), which contributes to objectionable odour. The biogas is emitted to the atmosphere. The open shallow lagoon aerobic treatment in the second stage will reduce the BOD to less than 100 mg/L, to meet the regulatory requirements for watercourse discharge.

Technology to be employed by the project activity

An efficient closed tank anaerobic digestion technology (The KS-CSTR digester system) will be implemented for the palm oil mill effluent (POME) treatment at BPI, to replace the existing deep open lagoon system for anaerobic digestion. The KS-CSTR digester system design has been optimised with respect to its treatment efficiency with the incorporation of a dual function mixing system in the digester tanks and maintaining adequate hydraulic retention time (~16-18 days). The anaerobic digester design takes into consideration the unique characteristics of POME in terms of its very high level of BOD, COD concurrent with high Suspended Solids and emulsified oil.

The treated effluent from the anaerobic digester tanks will be led to the existing shallow open lagoons for further aerobic treatment before discharging to the environment. In view of the high consistency of KS –CSTR digester system, the performance of the open lagoon aerobic treatment is expected to improve and hence it will achieve a consistent compliance with the regulatory effluent discharge requirements. The following is a flow diagram of the proposed project activity:



The KS-CSTR digester system is capable to achieve 80% treatment efficiency in the anaerobic digestion of COD input to the system. The methane generation rate has been estimated to be 0.25 kg CH_4/kg COD converted. or a production rate of approximately 28 m^3-biogas/m^3-POME is obtained. The closed tank KS-CSTR digester system allows for complete recovery of methane produced. The biogas generated shows basically the following composition and concentration ranges: 60-65% CH_4, 39-34% CO_2. 1500-3000 ppm H_2S. and the balance making up of water vapour.

Host country eligibility criteria

The following table shows that the project activity conforms to the national eligibility criteria set by the Designated National Authority of Malaysia.

Eligibility Criteria	Conformity by Project Activity
1. Sustainable Development Describe how the project addresses **one or more** of the following: i. Ensuring adequacy and security of fuel supply as well as promoting the utilisation of gas and renewable energy ii. Ensuring adequacy of electricity supply as well as improving productivity and efficiency iii. Developing the energy-related industries and services as well as increasing local content iv. Promoting Malaysia as a regional centre for energy-related engineering services v. Encouraging efficient utilisation of energy. particularly in the industrial and commercial sectors vi. Giving due importance to environmental considerations	i. The methane recovered can be used for heat generation, thus promoting the utilisation of biomass and renewable energy. ii. The project activity contributes to steam generation. iii. The project contributes to the development of energy-related industries and services as well as increasing local content. iv. The project will promote Malaysia as a regional centre for methane recovery from POME treatment as a new energy source. v. The project encourages the utilisation of POME as energy resource in the palm oil industrial sector. vi. The project contributes to GHG emission reductions and enhances the efficiency of POME treatment and thus improves the quality of the treated effluent discharge.
2. Environmental regulations	i. The project activity conforms to the

i. Has the project conformed to the environmental regulations of the country? ii. List the approvals (or exemptions) obtained	Environmental Quality Act 1974 and the relevant regulations therein. ii. The palm oil mill has been operating under a licence from the Department of Environment Malaysia as a Prescribed Premises in accordance with the requirements of the Environmental Quality (Prescribed Premises) (Crude Palm Oil) Regulations, 1977.
3. Technology to be employed and source of technology Show that the technology selected is "best available" for the project and indicate local content. It would be useful to provide a few examples of where the proposed technology has been employed and how it would facilitate technology transfer	The KS-CSTR closed tank anaerobic digester system for methane recovery selected is the "best available" technology considering the following factors: i. The KS-CSTR technology is the only proven and successful system for POME anaerobic digestion treatment and methane recovery: ii. There is no known and proven anaerobic digester technology for POME treatment available from outside Malaysia which is better than the technology selected; and iii. There have been a few attempts reported locally where a few other anaerobic digestion technologies have been applied for POME treatment, but none have been reported in successful commercial operations to-date.

A.4.4. Brief explanation of how the anthropogenic emissions of anthropogenic greenhouse gas (GHGs) by sources are to be reduced by the proposed CDM project activity, including why the emission reductions would not occur in the absence of the proposed project activity, taking into account national and/or sectoral policies and circumstances:

The "Forced Methane Extraction from Palm Oil Mill Effluent at Bell Palm Industry Sdn. Bhd.. Johor. Malaysia " project will reduce methane emissions to the atmosphere by the existing anaerobic open lagoon treatment system.

The reduction of methane emissions is achieved by the replacement of the existing open lagoon anaerobic treatment system with the closed tank KS-CSTR anaerobic digester system. Methane that is emitted from the existing open lagoons due to the natural anaerobic digestion process of the POME will thus be avoided. Methane generated in the closed tank anaerobic digester system will be captured and then utilised for heat production, or flared when the heat production system is not in operation.

No reduction of CO_2-emissions is expected from the utilisation of the methane recovered in the heating equipment, i.e. in the boiler for steam generation. The methane gas will only replace the use of palm kernel shells in the boilers. The kernel shells are renewable biomass fuel generated in the

mill production process. Excess palm kernel shells replaced can be sold as a biomass fuel, although at relatively low price.

The regulations under the Environmental Quality Act 1974 of Malaysia mandated treatment of POME to meet specific standards before the effluent is allowed to be discharged to the environment. The existing open lagoon system meets the current environmental standards. There are no regulatory provisions, which control the emission of methane from any wastewater treatment systems. The capital investment required for closed tank anaerobic digestion system far out-weights the financial return, which may be realised from the capture and utilisation of methane for heat and power generation. The project activity therefore would not have occurred without the additional revenue from the sale of the CERs provided by the CDM.

The project's additionality will be assessed by means of the "Tool for the demonstration and assessment of additionality" adopted by the CDM-EB in section B.3 of this document.

A.4.4.1. Estimated amount of emission reductions over the chosen crediting period:

The estimated amount of emission reductions over the first crediting period of 3 x 7 years is summarized in the table below.

Years	Estimation of annual emission reductions, t CO_2-e
2008	24,172
2009	24,172
2010	24.172
2011	24.172
2012	24,172
2013	24,172
2014	24,172
Total estimated reductions	169.204
Total number of crediting years for the first	7
Annual average over the crediting period of estimated reductions	24.172

A.4.5. Public funding of the project activity:

No public funding and official development assistance are used in the project activity. There are also no loans from international financial institutions.

SECTION B. Application of a baseline methodology

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

AM0013/Version02 "Forced methane extraction from organic waste-water treatment plants for grid connected electricity supply and/or heat production" as of May 13th, 2005 is applied. This methodology is based on the baseline approach from paragraph 48 of the CDM modalities and procedures "Existing actual or historical emissions as applicable".

B.1.1.Justification of the choice of the methodology and why it is applicable to the project activity:

The proposed project activity fulfils the applicability criteria defined in the methodology AM0013/Version 2 as follows:

Applicability criterion as defined in AM0013	Criterion met by project activity
Methane recovery project activities involving an industrial organic wastewater treatment plant	YES
Existing waste water treatment system is an open lagoon system, with:	YES
• depth of the open lagoon system is at least 1 m	YES
• residence time of the sludge in the open lagoons should be at least one year	YES
• temperature at the sludge in the open lagoons is always higher than 15°C	YES
The project activity includes a forced CH4 extraction	YES
There is a process change from open lagoon to accelerated CH4 generation in a closed tank digester or similar system	YES
Captured methane is used for electricity generation and/or for the production of heat	YES
The renewable power generation capacity is lower than 15 MW	YES

B.2. Description of how the methodology is applied in the context of the project activity:

The approved baseline methodology AM0013 is applied for the "Forced Methane Extraction from palm oil mill effluent at Bell Palm Industries Sdn. Bhd., Johor, Malaysia " in the assessment and estimation involving the following aspects: Project Emissions. Leakage. Baseline Emissions. Emission Reductions and Additionality for the project activity.

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In the application of AM0013, emission reductions are calculated as the difference between baseline and project emissions, taking into account potential sources of leakage, described as follows:

Baseline emissions are methane emissions from the existing open lagoons for POME treatment and CO2 emissions from the utilization of fossil fuels for heat and power generation. if any. for the industrial processes in the palm oil plant.

Project emissions include methane emissions from post-anaerobic treatment lagoons, and CO2 emissions associated with the digester auxiliary equipment (electricity consumption) and the heat and power generation process, if any.

No leakage is associated with the project activity in accordance with AM0013.

The project's additionality is determined by application of the "Tool for the demonstration and assessment of additionality" (Version 2) 28 November 2005, as decided at the 22nd Meeting of the CDM-EB. Details are provided in section B.3.

In line with AM0013 and considering that no electricity generation is involved, Emission Reductions (ERs) are calculated as follows:

$$ER\ [t\ CO_2e/yr] = Baseline\ emissions\ [t\ CO_2e/yr] - Project\ emissions\ [t\ CO_2e/yr]$$

With

Baseline emissions (t CO_2e/yr)	=	Baseline emissions from open lagoons (t CO_2e/yr)	+	Baseline emissions from grid electricity generation (t CO_2e/yr)	+	Baseline emissions from portion of fossil fuel displaced by biogas used in heating equipment (t CO_2e/yr)

and

Project emissions (t CO_2e/yr)	=	Emissions from open lagoons (t CO_2e/yr)	+	Physical leakage from biodigester (t CO_2e/yr)	+	Emissions from electric consumption by auxiliary heating equipment (t CO_2e/yr)

The relevant formulae defined in AM0013 will be applied accordingly for the calculation of baseline and project emissions. The estimation of GHG emissions by sources by applying these formulae will be presented in section E of this document.

Considering the provisions of AM0013, the calculation of ERs will be done *ex ante* ($ER\_CH_{4exante}$ - on the basis of the expected situation) and *ex post* ($ER\_CH_{4expost}$ - on the basis of monitored data). The lowest figure of $ER\_CH_{4exante}$ and $ER\_CH_{4expost}$ will be adopted for emission reductions determination.

Key information and data used to the baseline scenario (Quoted from Annex 3)

Parameter	Data source (*ex ante* figures)	Monitoring after project implementation	Value used for *ex ante* baseline calculation
Production capacity palm oil plant	Plant operator	--	800 tonnes/day
Production days	Plant operator	--	300 days/year
Flow rate of effluent (as generated by production process)	Plant operator, Measurement	YES	480 m^3/day
COD concentration of effluent (digester inlet)	Plant operator, Measurement	YES	64.5 g/litre
Reduction of COD in tank digester	Measurement	YES	80%
Biogas production	Measurement	YES	13,150 m^3/day

Biogas producing capacity (Bo)	Default value as specified in AM0013, based on IPCC default values	--	0.21 kg CH4/kg COD
Methane conversion factor (MCF)	Default value as specified in AM0013, based on IPCC default values	--	0.738
Electricity supplied to grid	Technical specifications, installation planning	YES	0
Global warming potential	UNFCCC	--	21
CH_4			
Calorific value biogas	Feasibility Study	YES	19.8 MJ/m^3
Calorific value palm kernel shells	Palm Oil Industry value in Malaysia	NO	13.8 MJ/kg
Regulations on discharge limits (COD)	Environmental Quality Act, 1974, Malaysia	YES	No applicable regulations on COD

More specific information on data that is to be monitored during the project activity as well as monitoring/recording frequencies are as specified in section D of this document.

B.3. 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:

The proposed CDM project activity on "Forced Methane Extraction from Palm Oil Mill Effluent at Bell Palm Industry Sdn. Bhd., Johor, Malaysia" contributes to the reductions of anthropogenic emissions by sources below those that would have occurred in the absence of the registered CDM project activity. The project activity would not have happened in the absence of the CDM.

In this section, the "Tool for the demonstration and assessment of additionality" (Version 2), 28 November 2005 as decided at the 22nd meeting of the CDM-EB are applied.

Step 0. Preliminary screening based on the starting date of the project activity

The project participants do not wish to have the crediting period starting prior to the registration of the project activity.

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

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

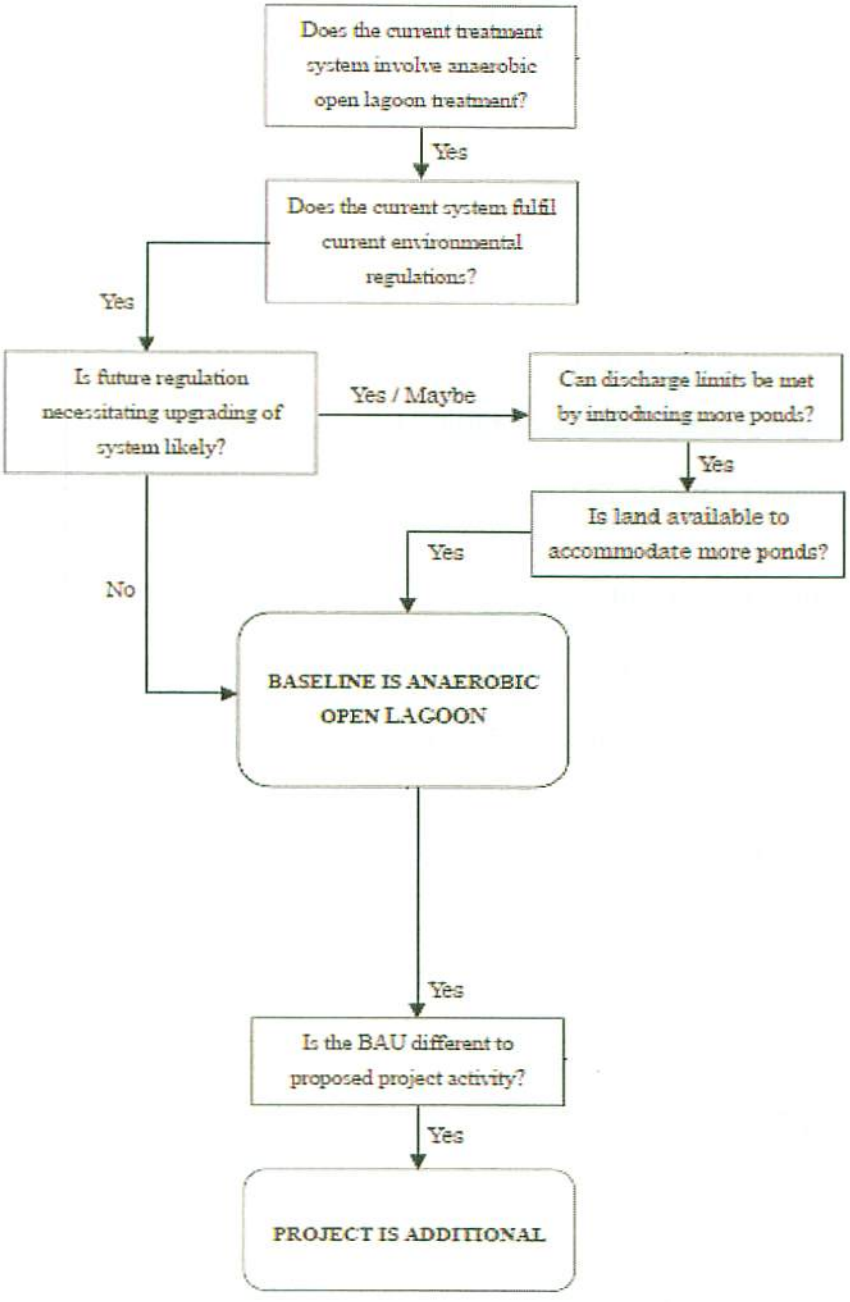
1. There are currently approximately 380 palm oil mills in Malaysia. For the treatment of the palm oil mill effluent (POME), there are only three known and proven technologies available to these mills and these are: (i) the open lagoon system involving deep open lagoon anaerobic digestion followed by aerobic treatment in shallow open lagoons or land application; the aerobic treatment may or may not incorporate mechanical aeration; (ii) the open tank anaerobic digestion system which also involves an aerobic treatment stage in shallow open lagoons or land application; the aerobic treatment may or may not incorporate mechanical aeration; and (iii) continuous flow stirred tank (closed) reactor for anaerobic digestion followed by aerobic treatment in shallow open lagoons or land application; the aerobic treatment may or may not incorporate mechanical aeration.

- The no project activity alternative, or the current situation, involves the first POME treatment technology of open lagoon system mentioned above, where methane generated is released to the atmosphere.
- The only other realistic and credible alternative is technology no. (ii) above, i.e. the open tank anaerobic digestion system, which is followed by aerobic treatment in shallow open lagoons or land application. However, this alternative neither contributes to methane emission reductions nor methane recovery for heat and power generation, as compared to the baseline scenario.
- If the adoption of a new technology which have not been proven for actual POME treatment application is considered as an alternative to the project activity, the project participants will be facing with the following risks, among others: (a) the system may never achieve the desired expectations for POME treatment: (b) the system may require long period of commissioning to rectify or optimise the operational conditions to achieve the desired performance: (c) unable to treat the POME effectively to meet the standards for discharge. Therefore, this alternative cannot be considered as realistic and credible.
- Therefore, if the proposed project activity is not undertaken as a CDM project activity, the only alternative is continuation of the current situation.

Sub-step 1b. Enforcement of applicable laws and regulations:

2. This step of the assessment, as illustrated in the flow diagram depicted in the following page, shows that the common open lagoon anaerobic digestion of POME represents the baseline scenario. On the other hand, the proposed project activity for replacing the open lagoon treatment by the closed-tank anaerobic digester system with methane recovery, will also be able to meet the applicable national laws and regulations, specifically, the Environmental Quality (Prescribed Premises) (Crude Palm Oil) Regulations, 1978, on the control of the quality of the effluent discharge to the environment.

The flow diagram also briefly summarized the procedures for Step 2 on "Investment Analysis" assessment on the project additionality.



Step 2. Investment analysis

The following investment analysis will show that the proposed project activity is economically or financially less attractive than other alternatives without the revenue from the sale of the CERs.

Since the CDM project activity generates some financial or economic benefits other than CDM related income, the following investment comparison analysis (Option II) is applied.

A financial analysis involving such concepts, as the IRR and cost comparison should be conducted and show that the project is not more economically/ financially attractive than the current waste water treatment system or other feasible alternatives.

The analysis should include, as a minimum, the variables below;
- Engineering, Procurement and Construction cost;
- Labour cost;
- Operation and Maintenance cost;
- Administration cost:
- Fuel cost:
- Capital cost and interest:
- Revenue from electricity sales.

Option II. Apply investment comparison analysis

The proposed project activity is characterised by the financial data as summarized in the table below. Malaysia does not have any supporting schemes nor subsidies to support projects on renewable energy development. Project developers have to find their own financing for the implementation of the projects.

Investments and incomes	RM
1. Initial investment	
1.1 Total capital costs for closed tank anaerobic digester system	3,000,000
1.2 Capital costs for conversion of biomass-fired boiler to biomass-biogas dual-fired boiler	200.000
2. Average annual expenditure	
2.1 O&M (5% of total investment per annum)	170.000
2.2 Personnel (technician, labourer, each1)	48,000
2.3 Average loan interest	96.000
3. Annual income	
3.1 Sale of palm kernel shells displaced	250.000
4. Payback period	Not viable
5. IRR	Not viable

Remarks
1. Interest rate of credit at 8% per year; for first 7 years of operation
2. Palm kernel shells price of RM50/t; 5,000 t kernel shells displaced per annum

Sensitivity analysis

The annual income from the sale of palm kernel shells displaced by biogas recovered is relatively low relative to the capital investment and annual expenditure.

Step 3. Barriers analysis

As has been pointed out above. anaerobic closed tank reactors currently are no common practice in Malaysian palm oil industry. The proposed project activity thus constitutes a new technological approach in this industry.

From the technical perspective, there is the risk of unstable or lower than anticipated heating values of the produced biogas.

Overall, the planned project activity makes a complex process monitoring and supervision necessary. Volumes and CH_4-contents of biogas need to be monitored permanently. the digestion process needs to be monitored chemically.

Step 4. Common practice analysis

Published information in the palm oil industry in Malaysia revealed that majority or over 90% of the 380 over palm oil mills employ open lagoon system for POME treatment. Less than 10% of these mills use open tank system for the anaerobic digestion process followed by aerated lagoon for the final effluent treatment. Two mills are known to have constructed closed tank anaerobic digesters for the POME treatment and methane recovery. but only one has been reported to be in continuing operation to-date. Therefore. the closed tank anaerobic digester system involving methane recovery cannot be considered a common practice in the palm oil industry in Malaysia.

Step 5. Impact of CDM registration

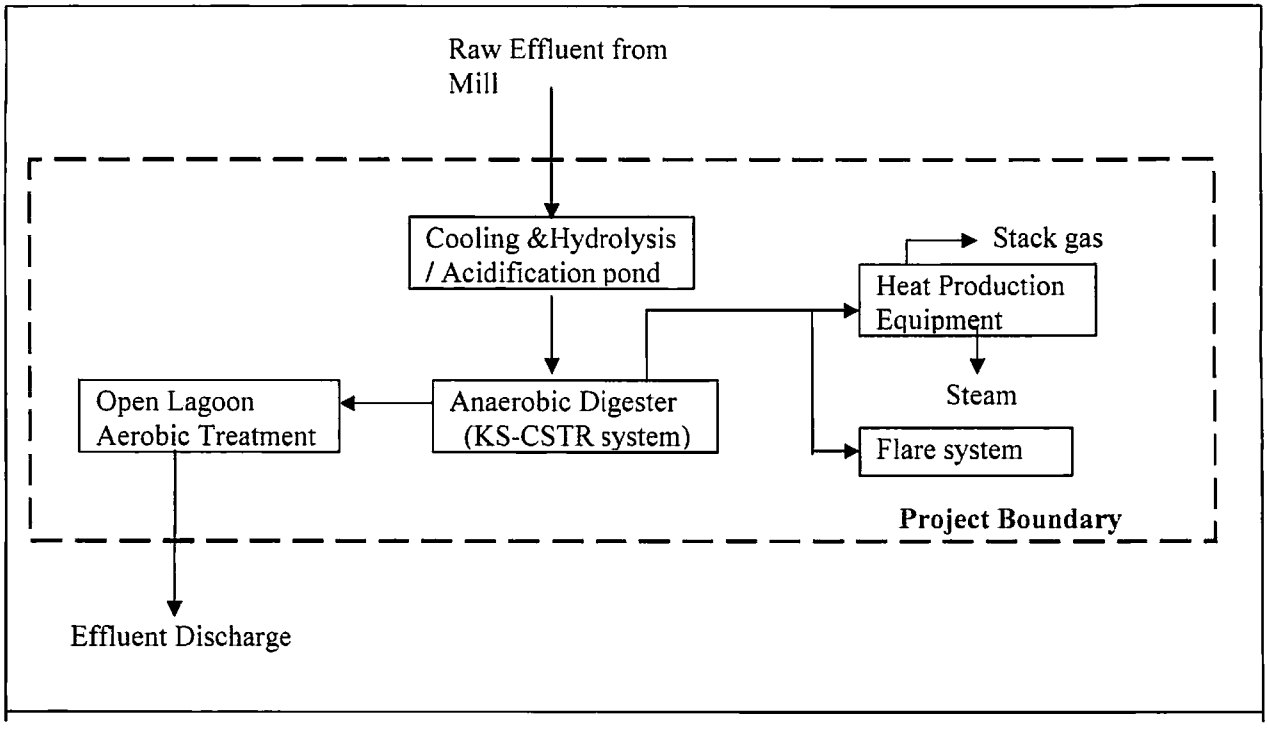
The range of expectation of additional income generated by selling CERs is RM453.226 – 906,452 annually. These figures are based on assumed CER prices of US$5.0/CER and US$10.0/CER, respectively.

Income through CERs	US$	RM
@ US$5.0 /CER	120.860	453,226
@ US$10.0/CER	241.720	906.452

It is apparent that the income from the CERs sales around US$10.0/CER will make the proposed project activity economically and financially viable.

B.4. Description of how the definition of the project boundary related to the baseline methodology selected is applied to the project activity:

The project boundary related to the baseline methodology selected is defined as the plant site. which includes all the relevant sections of the project activity. This is shown as follows.



B.5. Details of baseline information, including the date of completion of the baseline study and the name of person (s)/entity (ies) determining the baseline:

The baseline has been prepared by Sanwa Engineering Co., Ltd, Japan; Technova Inc., Japan and Novaviro Technology Sdn Bhd, Malaysia;

Company name: Sanwa Engineering Co., Ltd
Address: 1-27, Minami-futami, Futami-cho, Akashi-shi, Hyogo, Japan
Contact person: Toshio Tamura
Telephone number: +81-(0) 78-941-2000
Fax number: +81-(0) 78-941-1130
Email: tamura@sanwaeng.co.jp

Company name: Technova Inc.,
Address: 13th Fl. The Imperial Tower, 1-1-1 Uchisaiwai-cho, Chiyoda-ku Tokyo, Japan
Contact person: Hiromi Ishida
Telephone number: +81-(0) 3-3508-2280
Fax number: +81-(0) 3-3508-7578
Email: ishida@technova.co.jp

Company name: Novaviro Technology Sdn Bhd
Address: 6B, Jalan Astaka L U8/L, Bukit Jelutong
40150 Shah Alam, Selangor, Malaysia
Contact person: Dr. Soo Loong Tong

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Completion date of baseline: 31/01/2006
Technova and Novaviro Inc. are not project participants.

SECTION C. Duration of the project activity / Crediting period

C.1.1.Starting date of the project activity:

June 1st, 2006.

The starting date of the proposed project activity is the date on which the construction works of the project begins. The practical completion of the engineering works is expected to take six (6) months. The closed tank anaerobic digester system is expected to be in full operation in January 2007.

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

25 years.

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

C.2.1.Renewable crediting period

3 x 7 years.

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

1st January 2007, the expected date of successful commissioning of the system.

C.2.1.2. Length of the first crediting period:

7 years.

C.2.2.Fixed crediting period:

C.2.2.1. Starting date:

>>

C.2.2.2. Length:

>>

SECTION D. Application of a monitoring methodology and plan

This section shall provide a detailed description of the monitoring plan, including an identification of the data and its quality with regard to accuracy, compatibility, completeness and validity, taking into consideration any guidance contained in the methodology. The monitoring plan is to be attached in Annex 4.

D.1. Name and reference of approved monitoring methodology applied to the project activity:

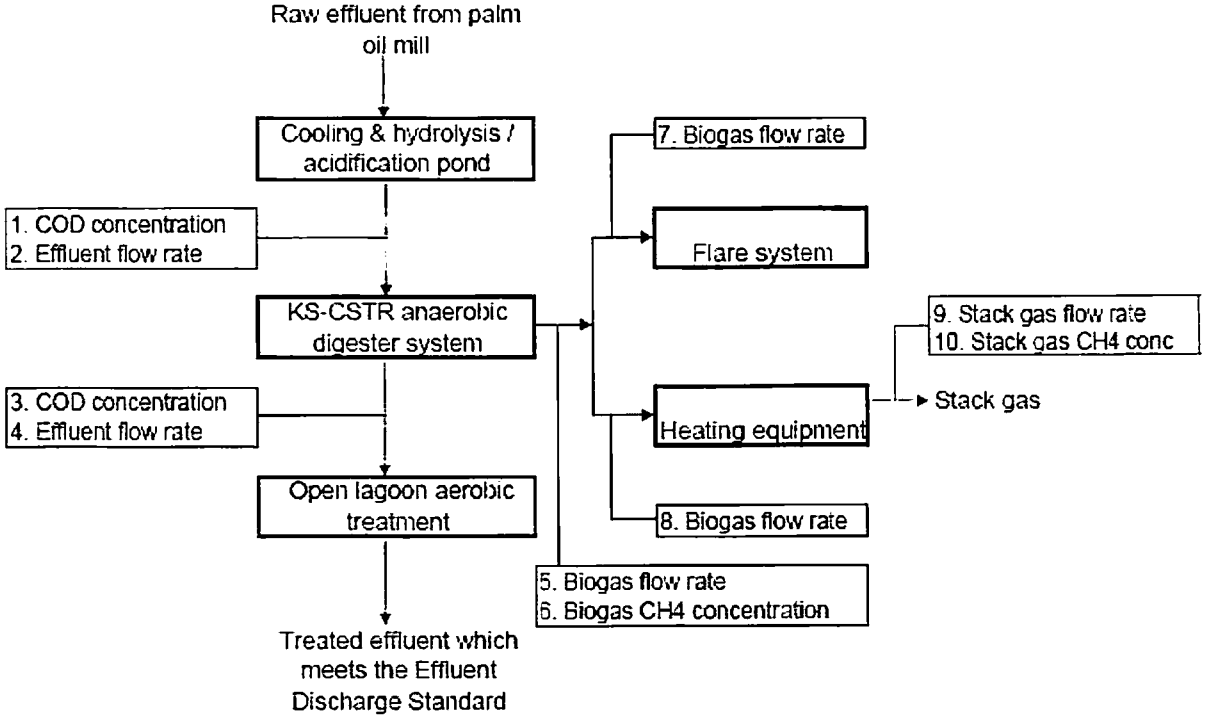
The monitoring methodology AM0013/Version02 "Forced methane extraction for grid-connected electricity supply and/or heat production" as of May 13th, 2005 will be applied.

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

The monitoring methodology AM0013 is applicable, because the underlying project activity fulfils all of the defined applicability criteria:

Applicability criterion	Criterion met by project activity
Methane recovery project activities involving an industrial organic wastewater treatment plant	YES
Existing waste water treatment system is an open lagoon system. with:	YES
- depth of the open lagoon system is at least 1 m	YES
- residence time of the sludge in the open lagoons should be at least one year	YES
- temperature at the sludge in the open lagoons is always higher than 15°C	YES
The project activity includes a forced CH4 extraction	YES
There is a process change from open lagoon to accelerated CH4 generation in a closed tank digester or similar system	YES
Captured methane is used for electricity generation and/or for the production of heat	YES
The renewable power generation capacity is lower than 15 MW	YES

The following figure summarizes the major monitoring points and the sequential numbers serve as the ID-numbering of the monitoring points. Details for the monitoring of the emissions in the project scenario and the baseline scenario for each of the monitoring points with the given ID-number are referred to in the respective monitoring tables.


Raw effluent from palm oil mill
Cooling & hydrolysis / acidification pond
1. COD concentration
2. Effluent flow rate
KS-CSTR anaerobic digester system
3. COD concentration
4. Effluent flow rate
Open lagoon aerobic treatment
Treated effluent which meets the Effluent Discharge Standard
7. Biogas flow rate
Flare system
9. Stack gas flow rate
10. Stack gas CH4 conc
Heating equipment
Stack gas
8. Biogas flow rate
5. Biogas flow rate
6. Biogas CH4 concentration

D.2. 1. Option 1: Monitoring of the emissions in the project scenario and the baseline scenario

D.2.1.1. Data to be collected in order to monitor emissions from the project activity, and how this data will be archived:

ID number *(Please use numbers to ease cross-referencing to D.3)*	Data variable	Source of data	Data unit	Measured (m), calculated (c) or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment
3.	COD concentration of effluent (at digester outlet	Measurement	kg COD/m3 raw effluent	m	at least monthly	100%	electronic	
4.	Flow rate of effluent (at digester outlet)	Measurement	m3 raw effluent/hr	m	continuously	100%	electronic	
5.	Biogas flow rate at digester outlet	Measurement	m^3/hr	m	continuously	100%	electronic	
6.	Biogas CH_4 content at digester outlet or heating equipment inlet	Measurement	%	m	Interval to satisfy statistical 95% confidence	-	electronic	

7.	Biogas flow rate at flare inlet	Measurement	m^3/hr	m	continuously	100%	electronic	
8.	Biogas flow rate at heating equipment inlet	Measurement	m^3/hr	m	continuously	100%	electronic	
9.	Stack gas flow rate (heating equipment)	Measurement	m^3/hr	m	continuously	100%	electronic	
10.	Stack gas CH_4 content (heating equipment)	Measurement	%	m	Interval to satisfy statistical 95% confidence	-	electronic	

All data will be kept for at least two years following the end of the crediting period or the last issuance of CERs (whatever is the later)

D.2.1.2. Description of formulae used to estimate project emissions (for each gas, source, formulae/algorithm, emissions units of CO_2 equiv.)

In accordance with AM0013, project emissions consist of methane emissions from the lagoons, physical leakage from the digester system and emissions related with the consumption of electricity in the digester auxiliary equipment. Project emissions are calculated according to the following formula:

Project emissions (t CO_2e/yr) = Emissions from open lagoons (t CO_2e/yr) + Physical leakage from biodigester (t CO_2e/yr) + Emissions from electric consumption by auxiliary equipment (t CO_2e/yr)

1. Methane emissions from post-treatment lagoons

Conservative calculation of emissions following the formula:

CH_4 emissions [t/yr] = COD at digester outlet (kg COD/yr) x Bo (kg CH_4/kg COD) x MCF x 0.001

where

COD	Is Chemical Oxygen Demand of effluent entering lagoons (measured)
Bo	Is maximum methane producing capacity
MCF	Is methane conversion factor (fraction)

The default IPCC value for Bo will be applied in a conservative manner with 0.21 kg CH_4/kg COD. Since the project is located in Asia, an MCF default value of 0.738 will be adopted[18]. Calculated CH_4 emissions are transformed into CO_2 equivalents by multiplying with its global warming potential (GWP) of 21.

2. Methane emissions from the digester system

The emissions directly associated with the digesters include physical leakage from the digester system. It was recommended in AM0013/Version 2 that the IPCC guidelines specify physical leakage from anaerobic digesters, as being 15% of total biogas production should be adopted. However, AM0013/Version 2 also states that "Where project participants use lower values for percentage of physical leakage, they should provide measurements proving that this lower value is appropriate for the project". In accordance with this provision, the project participants will use a value of 0% as the percentage of physical leakage. The project participants will provide *ex post* measurements to prove that the physical leakage from the anaerobic digester is negligible. The *ex post* measurements will be carried out directly on the closed anaerobic digester tanks, both fixed roof as well as floating roof (for gas holding) types, during the project commissioning stage. Tank leakage will be tested in two ways: (i) by hydraulic tests for the tanks for use as liquid storage; and (ii) gas pressure tests for the closed tanks to ensure no leakage for gas holding.

3. Emissions related with the consumption of electricity in the digester auxiliary equipment

Emissions related with the consumption of electricity by the digester auxiliary equipment will have to be accounted for. In the proposed project, digester auxiliary equipment which will consume significant electricity are the circulation pumps and gas pumps (estimated total of 80 kW) for the mixing of the POME in the tank reactors. Since the electricity will be supplied by the existing steam turbine power generation system of the palm oil mill which uses palm fibres and shells as fuel, the emissions related with the consumption of electricity in the digester auxiliary equipment is deemed to be negligible.

In line with AM0013, minor sources of project emissions associated fugitive CH4, and stack gas CH4 will be monitored after project implementation. If the emissions from an emission source are greater than 1% of the annual total CERs, they will be included as project emissions. There will be no additional greenhouse gas emissions due to fossil fuel consumption.

D.2.1.3. Relevant data necessary for determining the baseline of anthropogenic emissions by sources of GHGs within the project boundary and how such data will be collected and archived:

ID number *(Please use numbers to ease cross-referencing to table D.3)*	Data variable	Source of data	Data unit	Measured (m), calculated (c), estimated (e),	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment
1.	COD concentration of effluent (at digester inlet)	Measurement	kg COD/m^3 raw effluent	m	at least monthly	100%	electronic	
2.	Flow rate of effluent (at digester inlet)	Measurement	m_3 raw effluent/hr	m	continuously	100%	electronic	

All data will be kept for at least two years following the end of the crediting period or the last issuance of CERs (whatever is the later).

D.2.1.4. Description of formulae used to estimate baseline emissions (for each gas, source, formulae/algorithm, emissions units of CO_2 equiv.)

The baseline methodology as elaborated in AM0013 will be applied to the proposed project activity without changes. The following paragraphs summarize the relevant formulas and put them into context for the proposed project activity.

Baseline emissions are the CH_4 emissions from open lagoon wastewater treatment system. There are no CO_2 emissions associated with grid electricity generation that is displaced by the project, and no CO_2 emissions associated with fossil fuel combustion in the heating equipment.

1. Lagoon baseline emissions are calculated by applying the following formula:

CH_4 emissions [t/yr] = Total COD (kg COD/yr) x Bo (kg CH_4/kg COD) x MCF x 0.001

The COD will be measured directly as indicated above. The default IPCC value for Bo will be applied in a conservative manner with 0.21 kg CH_4/kg COD. Since the project is located in Asia, an MCF default value of 0.738 will be adopted[19]. Calculated CH_4 emissions are transformed into CO_2 equivalents by multiplying with its global warming potential (GWP) of 21.

2. Electricity baseline emissions are not relevant for the proposed project activity, since electricity generation is not intended.

3. Baseline emissions related to fossil fuel combustion are also not relevant for the project activity, since the boiler for steam generation for the mill originally uses fibres and shells.

D. 2.2. Option 2: Direct monitoring of emission reductions from the project activity (values should be consistent with those in section E).

In accordance with AM0013, option 1: Monitoring of the emissions in the project scenario and the baseline scenario has been selected for the proposed CDM project activity " Forced Methane Extraction from POME at Bell Palm Industry Sdn. Bhd., Johor, Malaysia".
Therefore, option 2: "Direct monitoring of emission reductions from the project activity" does not need to be developed.

D.2.2.1. Data to be collected in order to monitor emissions from the project activity, and how this data will be archived:

ID number *(Please use numbers to ease cross-referencing to table D.3)*	Data variable	Source of data	Data unit	Measured (m), calculated (c), estimated (e),	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment

This section is left blank on purpose.

D.2.2.2. Description of formulae used to calculate project emissions (for each gas, source, formulae/algorithm, emissions units of CO_2 equiv.):

This section is left blank on purpose.

D.2.3. Treatment of leakage in the monitoring plan

D.2.3.1. If applicable, please describe the data and information that will be collected in order to monitor leakage effects of the project activity

ID number *(Please use numbers to ease cross-referencing to table D.3)*	Data variable	Source of data	Data unit	Measured (m), calculated (c) or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment

This section is left blank on purpose.

D.2.3.2. Description of formulae used to estimate leakage (for each gas, source, formulae/algorithm, emissions units of CO_2 equiv.)

According to AM0013, there is no leakage associated with the proposed project activity.

D.2.4. Description of formulae used to estimate emission reductions for the project activity (for each gas, source, formulae/algorithm, emissions units of CO_2 equiv.)

The following formula is used to estimate emission reductions for the project activity:

Emission reductions (t CO_2e/yr)	=	Baseline emissions (tCO_2e/yr)	−	Leakage (t CO_2e/yr)	−	Project emissions (t CO_2e/yr)

D.3. Quality control (QC) and quality assurance (QA) procedures are being undertaken for data monitored		
Data *(Indicate table and ID number e.g. 3. - 1.; 3.2.)*	Uncertainty level of data (High/Medium/Low)	Explain QA/QC procedures planned for these data, or why such procedures are not necessary.
3.	Low	Sampling will be carried out adhering to internationally recognized procedures.
4.	Low	Flow meters will undergo maintenance/calibration subject to appropriate industry standards.
5.	Low	Flow meters will undergo maintenance/calibration subject to appropriate industry standards.
6.	Low	Sampling will be carried out adhering to internationally recognized procedures. This will be carried out at least Quarterly.
7.	Low	Flow meters will undergo maintenance/calibration subject to appropriate industry standards.
8.	Low	Flow meters will undergo maintenance/calibration subject to appropriate industry standards.
9.	Low	Flow meters will undergo maintenance/calibration subject to appropriate industry standards.
10.	Low	Sampling will be carried out adhering to internationally recognized procedures. This will be carried out at least Quarterly.
1.	Low	Sampling will be carried out adhering to internationally recognized procedures.
2.	Low	Flow meters will undergo maintenance/calibration subject to appropriate industry standards.

D.4Please describe the operational and management structure that the project operator will implement in order to monitor emission reductions and any leakage effects, generated by the project activity

The project operator will identify and plan for the monitoring tasks and interval, and assign appropriate staff, including management as well as technicians, to be responsible for the tasks.
The responsible staff will be given on-site training for conducting the respective monitoring tasks.

D.5Name of person/entity determining the monitoring methodology:

The monitoring methodology has been prepared by Sanwa Engineering Co., Ltd. Japan; Technova Inc., Japan and Novaviro Technology Sdn. Bhd., Malaysia.

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Company name: Novaviro Technology Sdn Bhd
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Completion date of baseline: 31/01/2006
Technova and Novaviro Inc. are not project participants.

SECTION E. Estimation of GHG emissions by sources

E.1. Estimate of GHG emissions by sources:

1. Methane emissions from the lagoons (project emissions)

Underlying data	
Discharge volume	480 m^3/day
COD-reduction in digester	80%
COD (digester outlet)	12.9 kg/m^3 COD
Bo	0.21
MCF	0.738

Lagoon project emissions		
POME flow rate	480 m^3/day	
COD (digester outlet)	12.9 kg/m^3 COD	
Days of mill operations	300 days/yr	
Total COD load	1,857,600 kg COD/yr	
CH_4 emissions	287,891 kg CH_4/yr	**288 t CH_4/yr**
		6,048 t CO_2-eq/yr

2. Physical biogas leakage from the digester system (project emissions)

The emissions directly associated with the digesters include physical leakage from the digester system. The IPCC guidelines specify physical leakage from anaerobic digesters as being 15% of total biogas production. However, as described in Section D.2.1.2, and following the provision of AM0013/Version 2, the physical leakage from anaerobic digesters has been assumed to be negligible.

3. CO_2-emissions related with the consumption of electricity in the digester auxiliary equipment.

Since the electricity for the digester auxiliary equipment will be supplied by the existing steam turbine power generation system of the palm oil mill which uses palm fibres and shells as fuel, the emissions related with the consumption of electricity in the digester auxiliary equipment is deemed to be negligible.

External heating of the effluent for the waste water treatment process is not necessary for operations in tropical countries such as Malaysia, as the ambient temperature is normally more than 25 °C.

Total estimated project emissions amount to 6,048 tons CO_2-eq/yr. Details are provided in the table below.

TOTAL PROJECT EMISSIONS	
1. Lagoon project emissions	6,048 t CO_2-eq/yr
2. Physical leakage from digester	Negligible
3. Digester auxiliary equipment	Negligible
Total	6,048 t CO2-eq/yr

E.2. Estimated leakage:

According to AM0013, leakage is not applicable for the project type under consideration.

E.3. The sum of E.1 and E.2 representing the project activity emissions:

Total estimated project emissions amount to 6,048 t CO_2-eq/yr. Details are provided in the table below.

TOTAL PROJECT EMISSIONS	
1. Lagoon project emissions	6,048 t CO_2-eq/yr
2. Physical leakage from digester	Negligible
3. Digester auxiliary equipment	Negligible
4. Leakage	0
Total	**6,048 t CO_2-eq/yr**

E.4. Estimated anthropogenic emissions by sources of greenhouse gases of the baseline:

1. CH4 emissions from open lagoons

Underlying data	
Discharge volume	480 m^3/day
COD	64.5 kg/m^3 COD
Bo	0.21
MCF	0.738

Lagoon baseline emissions		
POME flow rate	480 m^3/day	
POME COD conc.	64.5 kg/m^3 COD	
Production per year	300 days/yr	
Total COD load	9,288,000 kg COD/yr	
CH_4 emissions	1,439,000 kg CH_4/yr	**1,439 t CH_4/yr**
		30,219 t CO_2-eq/yr

Expected baseline lagoon emissions amount to 30.219 t CO_2-eq/yr.

2. CO2-baseline emissions from electricity supply

Electricity baseline emissions are not relevant for the proposed project activity, since no electricity generation for grid connection is intended.

3. CO2-baseline emissions from fossil combustion emissions
This is not applicable to the proposed project activity since no fossil fuel combustion is displaced.

4. Total baseline emissions

In total, baseline emissions amount to **30,219 t CO_2-eq/yr**

E.5. Difference between E.4 and E.3 representing the emission reductions of the project activity:

Emission reductions are calculated as the difference between baseline emissions and project emissions in line with the provisions in AM0013. While effective emission reductions will be determined *ex-post* on the basis of measured data, an *ex-ante* estimation of expected emission reductions of the first 7-year crediting period is provided below.

Expected baseline emissions from E.4 30.219 t CO_2-eq/yr
Expected project emissions from E.3 6.047 t CO_2-eq/yr

Expected emission reductions (*ex ante*) 24,172 t CO_2-eq/yr

E.6. Table providing values obtained when applying formulae above:

The expected emission reductions for the first 7-year crediting period are provided below:

Years	Estimation of Project emissions in tons of CO_2 e	Estimation of Baseline emissions in tons of CO_2 e	Estimation of Leakage (tons CO_2 e)	Estimation of Emission reductions in tons of CO_2 e
2008	6,048	30,219	n.a.	24,172
2009	6,048	30,219	n.a.	24,172
2010	6,048	30,219	n.a.	24,172
2011	6,048	30,219	n.a.	24,172
2012	6,048	30,219	n.a.	24,172
2013	6,048	30,219	n.a.	24,172
2014	6,048	30,219	n.a.	24,172

SECTION F. Environmental impacts

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

According to the Malaysian environmental laws and regulations, specifically the Environmental Quality Act 1974 and the Environmental Quality (Prescribed Activities) (Environmental Impact Assessment), no environment impact assessment is required for the proposed project activity.

The project must comply with the environmental laws and regulations and the project proponent must obtain the necessary approvals before project implementation.

The project involves an upgrading of the existing POME treatment system at the palm oil mill. Significant environmental improvements and benefits can be realised through the implementation of the proposed project activity involving the installation of an advanced anaerobic digester system based on the CSTR technology for methane recovery, in place of the existing open lagoon system for POME treatment.

F.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:

In accordance with the environmental laws and regulations in Malaysia, environmental impact assessment is not required for the proposed project activity.

SECTION G. Stakeholders' comments

This section will be completed.

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

>>

G.2. Summary of the comments received:

>>

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

>>

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

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Personal E-Mail:	

Annex 2

INFORMATION REGARDING PUBLIC FUNDING

No public funding is involved in the project activity.

Annex 3

BASELINE INFORMATION

The baseline methodology as elaborated in AM0013 has been applied to the proposed project activity. The following descriptions summarize the relevant formulae as applied to the project.

Baseline emissions will only involve the CH_4-emissions from open lagoon wastewater treatment system. No fossil fuel displacement in the heating equipment for steam generation is expected in the proposed project. The proposed project also has no plan for power generation, and thus CO_2 emission reductions associated with replacement of grid electricity are not relevant for the project.

Lagoon baseline emissions are calculated by applying the following formula:

CH_4 emissions =	Total COD	x	Bo	x	MCF
(kg/yr)	(kg COD/yr)		(kg CH_4/kg COD)		

The COD will be directly measured, also see section D. The default IPCC value for Bo will be applied in a conservative manner with 0.21 kg CH_4/kg COD. Since the project is located in Asia, an MCF default value of 0.738 will be adopted.

Electricity baseline emissions are not relevant since the proposed project has no plan for power generation for connection to the grid.

The following table summarises the data used in the *ex-ante* calculations of baseline emissions:

Table: Baseline emissions

Parameter	Data source (*ex-ante* figures)	Value used for ex-ante baseline calculation
Production capacity of the palm oil mill at Bell Palm Industry	Plant operator	800 tons/day
Production days per year	Plant operator	300 days/year
Effluent generated from the mill production process	Plant operator; measurement	480 m3/day
COD concentration of effluent (at digester inlet)	Plant operator; measurement	64.5 g/litre
Reduction of COD in tank digester	Measurement of COD concentration	80%
Biogas production	Measurement	13,150 m3/day (35 oC)
Biogas producing capacity (Bo)	Default value as specified in AM0013, based on IPCC default values	0.21 kg CH4/kg COD
Calorific value biogas	Feasibility study	19.8 MJ/m3
Calorific value palm shells	Desk Study on Palm Oil Industry in Thailand	13.8 MJ/kg
Methane conversion factor (MCF)	Default value as specified in AM0013, based on IPCC default values	0.738
Electricity supplied to grid	Technical specifications, installation planning	0
Technical lifetime	Technology provider	25 years
Global warming potential CH4	UNFCCC	21
Regulations on discharge limits	Environmental Quality Act, 1974, Malaysia	Standard limits set for BOD but not on COD.

Considering the provisions of AM0013, the calculation of ERs will be done *ex-ante* ($ER\_CH_{4\,exante}$ - on the basis of the expected situation) and *ex-post* ($ER\_CH_{4\,expost}$ - on the basis of monitored data). The lowest figure between $ER\_CH_{4\,exante}$ and $ER\_CH_{4\,expost}$ will be adopted for final emission reductions determination.

Annex 4

MONITORING PLAN

The monitoring plan, including type and technical specification of monitoring instruments, best practices on monitoring procedures, and QA/QS, will be completed.