CLEAN DEVELOPMENT MECHANISM
PROJECT DESIGN DOCUMENT FORM (CDM-SSC-PDD)
Version 03 - in effect as of: 22 December 2006

CONTENTS

Annexes

Revision history of this document

Version Number	Date	Description and reason of revision
01	21 January 2003	Initial adoption
02	8 July 2005	• The Board agreed to revise the CDM SSC PDD to reflect guidance and clarifications provided by the Board since version 01 of this document. • As a consequence, the guidelines for completing CDM SSC PDD have been revised accordingly to version 2. The latest version can be found at <http://cdm.unfccc.int/Reference/Documents>.
03	22 December 2006	• The Board agreed to revise the CDM project design document for small-scale activities (CDM-SSC-PDD), taking into account CDM-PDD and CDM-NM.

SECTION A. General description of small-scale project activity

A.1 Title of the small-scale project activity:

FELDA Serting Hilir Biogas Power Plant Project
Document version: 1.0
Date of completion: 21 February 2008

A.2. Description of the small-scale project activity:

The '**FELDA Serting Hilir Biogas Power Plant Project**' (hereafter referred to as "the Project") developed by FELDA Palm Industries SDN BHD (hereafter referred to as the "Project Developer") and EcoSecurities Group PLC (EcoSecurities) consists of the construction and operation of 3 closed biogas digester tanks and a grid connected biogas power generation plant, located at Serting Hilir, Negeri Sembilan, Malaysia, hereafter referred to as the "Host Country".

The purpose of the project activity is to utilize the methane gas generated from the anaerobic treatment of palm oil mill effluent (POME). The methane gas will be captured by converting the existing open anaerobic digester tanks in the mill to closed type anaerobic digester tanks. Then the methane will be utilized to run a 647 kW gas engine (later upgraded to 1,294 kW) as electricity generator. The electricity generated will replace the use of a diesel genset and will be exported to the Tenaga Nasional Berhad (TNB) grid.

FELDA Palm Industries SDN BHD is an integrated palm oil company that operates 71 palm oil mills (including the 'Serting Hilir' mill, where the proposed project activity will take place) and is one of Malaysia's leading producer of Crude Palm Oil (CPO) and Palm Kernel Oil (PKO). Processed Fresh Fruit Bunches (FFB) predominantly comes from its own plantations and partly from the small holder plantations. An overview of the FELDA Serting Hilir mill is presented in Table 1. For its part, EcoSecurities is a leading CDM/JI project development company.

Table 1. Overview of the Serting Hilir Palm Oil Mill.

Parameter	Description
Location	Negeri Sembilan, West Malaysia
Commissioned	1987
Capacity	54t FFB/h
FFB processed	2007: 269,580 t FFB – Average 2005-7: 287,587 t FFB
Processing hours/year	2007: 4,992 hours
POME treatment method	Anaerobic and aerobic ponds – 2 cooling ponds, 3 mixing ponds, 6 anaerobic tanks, 2 facultative pond and 12 algae ponds.
COD in POME (untreated)	50,000 to 65,000 mg/l (variable, depending on season)
COD in POME (discharged)	500 mg/l
POME quantities	2007: 192,372 m^3 – Average 2005-7: 205,222 m^3
Boiler	2 x Tukuma N375 – 25,000 lb/hr
Turbine	2 x Nadrowski C5 SG 4 – 650kW

GenSets	2 x Cummins NTA855 – 250kW
Transmission line	Tenaga Nasional Berhad (TNB) substation within 7km from the mill

Baseline Scenario

The FELDA Serting Hilir Mill processes FFB to produce crude palm oil and crude palm kernel oil. Currently, the mill is processing an average of 287,587 tonnes of FFB per year. For the processing of FFB, steam is used for sterilization and hot water for dilution. All these streams produce wastewater with high organic content, known as Palm Oil Mill Effluent (POME). On average, the mill produces 0.70 m^3 POME per tonne of FFB[1]. The POME has a high content of organic matter – typically 50,000 – 65,000 mg Chemical Oxygen Demand (COD)/litre of raw POME. POME is immediately piped from the mill to a de-oiling tank before it is pumped to cooling and mixing ponds for further treatment. Then the wastewater is treated in six open anaerobic tanks. The POME is fed into the lower section of the tank via an influent pipe, in a continuous mode. An equal volume of treated wastewater is displaced and it leaves the digester via an effluent pipe from the top of the tank, and is directed by gravity flow into the secondary facultative pond system. Each tank has a capacity of 3,600m^3 and the retention time of the wastewater is 20 days. These open tank digesters are constructed from steel plates welded in a cylindrical shape with an internal tar-epoxy coating, and set on a reinforced concrete base. Accumulation of sludge does occur and the tanks are drained almost every two weeks, the sludge is dried in three shallow pits (1-2ft) and then sold to smallholder farmers and used as fertilizer in their plantations. During the treatment in the open tanks methane is emitted. After treatment in the tanks, the wastewater is piped to two facultative ponds (depth of 2.5, anaerobic) and twelve algae ponds (depth 2m, aerobic) with a retention time of 40 days. The COD in the outlet from the open anaerobic tanks is around 13,000 – 15,000 mg COD/litre. After a succession of algae ponds, at discharge level the wastewater has an organic load of around 500 mg COD/litre. The treated wastewater is discharged on a waterway and complies with requirements for a maximum of 100 mg BOD/litre[2].The current wastewater system for the mill is presented in Annex 3.In regards to electricity generation, in the baseline, electricity is supplied to the mill by the boilers and turbines using fibres and shells. A diesel genset also operates during start-up and maintenance of the mill. No electricity is imported or exported from the grid.

Project scenario

The project will claim emissions reductions through (1) avoidance of methane production from the open tank and pond anaerobic treatment of POME; (2) the export of renewable electricity to the grid and (3) the displacement of electricity from the diesel den-sets of the mill. The project activity involves the retrofitting of the existing open tanks which will be converted to one holding tank, three reactor tanks, one gas storage tank and one standby tank. The top portion of the tanks will be refurbished and enclosed to capture the biogas. The biogas will be combusted in a 647kWe (Phase I) and later in a 1,294kWe (Phase II) gas engine. Some of the generated electricity will be used for the operation of the biogas plant. Also, electricity will be used to replace the stand-by diesel genset. In addition, electricity will be provided for the aeration of treated effluent to remove remaining BOD in Phase II. The remainder of the generated electricity will be exported to the Peninsular Malaysia grid through Tenaga Nasional Berhad (TNB). The baseline emission of the Peninsular Malaysia grid is found to be 0.620 tCO_2/ MWh[3]. The baseline and project scenarios are summarised in Table 2.

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[1] Standard Mass Palm Oil Mill Flow Diagram (10,000kg of FFB – 7,136 kg of Mixed Raw Effluent)-Jurutera Profesional Mekanikal Ir Mohd Rozali B Ahmad, Malaysia.

[2] Environmental Quality Act 1974 (Act 127), 20th July 2006 – Environmental Quality) Prescribed Premised) (Crude Palm Oil) Regulations 1977, Paragraph 13: Limits for parameters of effluent to de discharged onto land.

[3] Ministry of Energy, Water and Communications, PTM, DANIDA (April 2006). Study on Grid Connected Electricity Baselines in Malaysia. The study referred to 0.631 t CO2e /MWh for Peninsula Malaysia. However in recent meeting of the CDM

Table 2. Summary of baseline and project scenarios.

Parameter	Baseline	Project	
		Phase I	Phase II
POME	Treated in open anaerobic tanks and anaerobic ponds	Treated in closed anaerobic reactor tanks and anaerobic ponds	Treated in closed anaerobic reactor tanks and aerobic tank
Electricity	No electricity supplied to the grid	Electricity supplied to the grid (647 kWe generator)	Electricity supplied to the grid (1,294 kWe generator)
Diesel	Diesel used in the gen-set of the mill (250 kWe)	Electricity from the biogas plant to replace diesel used in the genset (250kWe)	Electricity from the biogas plant to replace diesel used in the genset (250kWe)

Contribution to Sustainable Development and Compliance with the Malaysian National CDM criteria

The Project will have positive contribution to the Sustainable Development of the Host Country, as defined by the Country's Designated National Authority[4]:

<u>Criterion 1 - The project must support the sustainable development policies of Malaysia and bring direct benefits towards achieving sustainable development</u>

- **Social and economic**
  - Contributing to a small increase in the local employment by employing skilled and un-skilled personnel for operation of the composting plants and maintenance of the equipment. The Project will demonstrate that innovative solutions could be applied for the management of palm oil mill waste creating a dynamic sector of economic activity in the Host Country that could have positive employments effects.
  - The generation of electricity from biogas will result in increasing the diversity and security of electricity supply in the Host Country. On a national scale, the project will contribute to a decrease in fuel imports.

- **Technology**
  - The proposed project will result in technology and know-how transfer by applying the integrated biogas and electricity generation technologies. This will constitute a best practice' application for the management of industrial waste in the palm oil sector in the Host Country. The successful design and operation of such facilities will encourage local enterprises, local authorities and financing institutions to support entrepreneurial activities in the palm oil mill waste management sector in regional and national level.

- **Environmental**
  - The proposed project will result in significant reduction in the emissions of Greenhouse Gases. The project will reduce green house gas emissions by avoiding the release of methane from the treatment of POME in anaerobic open tanks and ponds and by

Technical committee of Malaysia (15/02/2008) it was decided that updated values are for small scale projects: Peninsular Malaysia – 0.620 tCO_2/MWh, which is used in the project.

[4] Malaysia Handbook for Clean Development Mechanism, *Pusat Tenaga Malaysia*. Cited at: http://cdm.eib.com.my

substituting the electricity requirement from the grid with a source of renewable energy thereby eliminating the generation of equivalent quantum of electricity using fossil fuel.

- Odour problems in the existing pond system will be reduced.

Criterion 2 - Implementation of CDM projects must involve participation of Annex I Party/Parties

The Annex I party in the implementation of this project is EcoSecurities Group Plc, an authorized private entity from an Annex I Party. EcoSecurities will be participating as buyer of the carbon credits.

Criterion 3 - Project must provide technology transfer benefits and/or improvement in technology

The proposed project activity is one of the first grid-connected biogas project in the palm oil sector in the Host Country (refer to Section B.5). The proposed project is the commercial phase of a previous Research Pilot Project which was implemented for two years (July 2004-July 2007). The Research consortium included the Universiti Putra Malaysia, the Kyushu Institute of Technology, Japan and FELDA Palm Industries Sdn. Bhd. The pilot project established a Biogas Pilot Plant at Serting Hilir which was designed by Sumitomo Heavy Industries Pty. Ltd (Japan) and constructed by the Workshop Division of FELDA Palm Industries Sdn. Bhd. The key objective of the pilot phase was to demonstrate the operation of a closed anaerobic digester tank for POME treatment. Overall the research project helped the project developer to develop skills and know-how in dealing with commercial POME biogas plant. The technology provider for the proposed project is CST Engineering S/B, a local company but more than 50% of the share holder is Danish. The technology will be from Denmark and the machinery will be from Germany for the gas engine and Switzerland for the membrane. Some of the pumps also will be bought from the US. The proposed project is the result of the previous pilot work which included transfer to technology in the field of biogas applications from Annex I to non-Annex I countries.

Criterion 4 - Project must fulfil all conditions underlined by the CDM Executive Board:

a. The project developer's participation is voluntary; and

b. Section B.5 discusses the long-term benefits related to mitigation of climate change and the reductions in emissions that are additional to any that would occur in the absence of this project activity.

Criterion 5 - Project proponent should justify the ability to implement the proposed CDM project activity

FELDA Palm Industries Sdn Bhd is a local company with paid-up capital of more than RM100,000 or USD25,000. FELDA will be financing the project using internal equity.

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 wished to be considers as project participant
The Government of Malaysia (host)	FELDA Palm Industries Sdn. Bhd.	No
United Kingdom of Great Britain and Northern Ireland	EcoSecurities Group PLC.	No

A.4. Technical description of the small-scale project activity:

A.4.1. Location of the small-scale project activity:

A.4.1.1. Host Party(ies):

Malaysia

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

The state of Negeri Sembilan, in West Malaysia.

A.4.1.3. City/Town/Community etc:

District of Jempol.

A.4.1.4. Details of physical location, including information allowing the unique identification of this small-scale project activity :

The project activity site is located in Serting Hilir in district Jempol. The project site is located 25 km from the nearest town of Bahau. The site is well connected by road. The latitude and longitude for the biogas plant site is 2^{o} 48’ N and 102^{o} 22’ E respectively.

A.4.2. Type and category(ies) and technology/measure of the small-scale project activity:

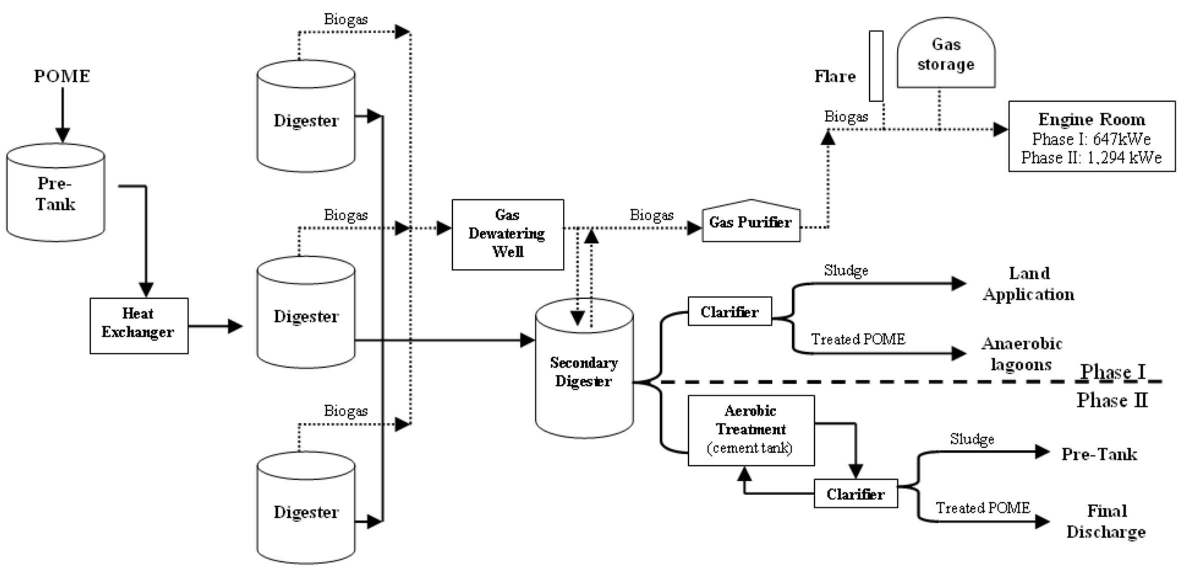
According to Appendix B to the *Simplified Modalities and Procedures for Small-Scale CDM Project Activities (Version 11, 20 June 2007)*, the Project type and categories are defined as follows:

Methane avoidance component:
Type III: Other project activities
Category III.H: Methane Recovery in Wastewater Treatment
Sectoral Scope 13: Waste handling and disposal

Electricity generation component:
Type I: Renewable energy projects
Category I.D: Grid connected renewable electricity generation
Sectoral Scope 1: Energy industries (renewable /non-renewable sources)

Technology employed for the project activity

Figure 1. Process diagram of the Serting Hilir Biogas plant.



Digester component: The project activity involves the retrofitting of five of the existing open tanks with enclosed steel roofs. The digesters will treat the wastewater on a continuous-flow basis (i.e. continuous feeding of influent and continuous discharge of effluent from the digesters throughout the operation). Proper mixing and circulation inside the tank will be used to optimise the methane generated from every kg of COD in the wastewater (the current open anaerobic tank doesn't have a circulation and mixing system). The first will be a holding tank to accept the POME from the mill. After the holding tank, the POME will go through a heat exchanger to reduce the temperature of POME to around 50^{o}C. Then, the POME will be treated in the three closed tanks. Biogas will be collected in another gas storage tank, then purified in a H_2S scrubber and then connected to the flare and gas generator. The treated POME after the digester will go to a secondary digester where sludge will be removed and finally to a new concrete tank where the wastewater will be treated aerobically using aerators. The conversion of the open tank to the closed tank will result in the capture of the methane gas instead of the gas being directly released to the atmosphere. An average of 50% concentration of CH_4 is expected in the biogas. At least 90% removal of the COD load is also expected in the digesters. Any sludge generated in the digesters will be dried in three shallow pits (1-2ft) and then sold to smallholder farmers and used as fertilizer in their plantations, as in the baseline scenario.

Electricity generation component: The biogas engine type selected is the Deutz TCG 2016 V16K with a nominal capacity of 647kWe. After an initial testing period, in Phase 1 of the project, the biogas will be used for combustion in one 647kWe gas generator for the first 2 years. In Phase 2, another gas generator will be installed, increasing the total capacity at 1,294kWe. Any excess biogas will be flared in an enclosed flare (Table 3). The biogas plant will be equipped with standard safety features including explosion proof equipment; flame arrestor and breather valve installation wherever necessary. The safety system should be functional at every time and being considered in every part of the design. The electricity generated will be given priority to be fed to the mill for power required during the start-up and during any breakdown time. Only when the mill is not running will the electricity will be fully exported to the medium voltage distribution network of TNB. The plant will operate in parallel with the TNB network continuously. There will be a new Connection 1.5MW Point (11kV) located at Pusat Latihan Polis, 7.5km from the mill.

Table 3. Electricity generated in Phase I and Phase II.

Parameter	Value	Unit	Rationale
			Phase I
	500	kW	Capacity of the gas engine at Phase I (assume that 500kW of the total nominal capacity of 647kW will be used)
	70	kW	Biogas Plant parasitic energy
	7,008	h/yr	Annual Operating Hours – Load factor of 80% expected therefore 8,760h/y * 80% = 7,008h/y
$EG_{y,Phase\ I}$	3,013,440	kWh/yr	Annual expected electricity generated (430kW * 7,008h = 3,013,440 kWh/year)
	250	kW	Capacity of displaced diesel genset
	1,452	h/yr	Historical operating hours for the genset (2007)
$EG_{y,\ mill}$	362,900	kWh/yr	250kW * 1,452h = 362,900 kWh/yr
$EG_{y,grid,PhaseI}$	2,650,540	kWh/yr	Electricity exported to the grid under Phase I
			Phase II
	1,000	kW	Capacity of the gas engine at Phase II (assume that 1,000kW of the total nominal capacity of 1,294kW will be used)
	70	kW	Gas engine parasitic load
	7,008	h/yr	Annual Operating Hours – Load factor of 80% expected therefore 8,760h/y * 80% = 7,0008h/y
$EG_{y,Phase\ II}$	6,517,440	kWh/yr	Annual expected electricity generated (930kW * 7008h = 6,517,440 kWh/year
$EG_{y,\ mill}$	362,900	kWh/yr	250kW * 1,452h = 362,900 kWh/yr (as above)
	80	kW	Capacity of the aerators of aerobic treatment concrete tank
	8,760	h/yr	Operate 8,760hours/year
$EG_{y,\ aerators}$	700,800	kWh/yr	Electricity used for aerators
$EG_{y,grid,PhaseII}$	5,453,740	kWh/yr	Electricity exported to the grid under Phase II

A net meter will be installed to measure the actual electricity being sold to the grid after the deduction for the internal usage. The interconnection of the TNB's Medium Voltage Distribution Network will be conducted following standards technical requirements[5]. It is expected that the net electrical energy

[5] These include the 'Guidebook of the Technical Requirements for the interconnection of a User's Network to TNB's Medium Voltage Distribution Network', the 'Malaysian Grid Code' and the 'Malaysian Distribution Code'.

available for export will be 2,650,540 kWh/year for phase I (500kWe utilised) and 5,453,740 kWh/year for phase II (1,000kWe utilised) (summarised in Table 3). A Renewable Energy Power Purchase Agreement (REPPA) is currently under negotiation between TNB and the project developer.

A.4.3 Estimated amount of emission reductions over the chosen crediting period:

Years	Annual estimation of emission reductions over the chosen crediting period
Year 1 (Sept-Dec)	11,618
Year 2	34,853
Year 3	35,908
Year 4	38,017
Year 5	38,017
Year 6	38,017
Year 7	38,017
Year 8	38,017
Year 9	38,017
Year 10	38,017
Year 11 (Jan-Aug)	25,345
Total estimated reductions (tonnes of CO_2)	373,846
Total number of crediting years	10
Annual average over the crediting period of estimated reductions (tonnes of CO_2)	37,385

A.4.4. Public funding of the small-scale project activity:

The project will not receive any public funding from Parties included in Annex I to the United Nations Convention on Climate Change.

A.4.5. Confirmation that the small-scale project activity is not a debundled component of a large scale project activity:

Based on the criteria set to determine the occurrence of debundling[6], it is confirmed that the project activity is not a debundled component of a large project activity as the project participants did not register or applied for another small-scale CDM project activity:

- in the same project category and technology/measure; and
- registered within the previous 2 years; and
- whose project boundary is within 1 km of the project boundary of the proposed small-scale activity at the closest point of a larger project activity.

[6] Appendix C of the Simplified Modalities & Procedures for Small-Scale CDM project activities – Determining the occurrence of debundling.

SECTION B. Application of a baseline and monitoring methodology

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

The following approved baseline methodologies are applicable to the project activity:

(1) For the methane avoidance component of the project:
AMS-III.H. version 08 – *Methane Recovery in Wastewater Treatment*

(2) For the Electricity generation component of the project:
AMS I.D. version 13 – *Grid connected renewable electricity generation*

B.2 Justification of the choice of the project category:

The proposed project activity meets all the applicability requirements of AMS III.H. as follows:

- The Project comprises measures that recover methane from biogenic organic matter in wastewater by means of introduction of a methane recovery system, such as an anaerobic reactor, and combustion to an existing anaerobic wastewater pond treatment system

- The total estimated emissions reductions of the project activity will be on average 37,385 tCO_2e per year for the methane avoidance component and does not exceed $60ktCO_2e$ in any year of the crediting period.

The approved small-scale methodology AMS-I.D is applicable to the project activity due to following reasons:

- The Project comprises a renewable energy generation unit with a maximum output capacity of 1.294 MW, therefore not surpassing the 15 MW limit
- The generated electricity will be transferred to the Peninsula Malaysia Power Grid, in which fossil fuel fired power plants account for the predominant share of electricity generation.

The project participants confirm that the installed capacity of the Project will not be increased throughout the crediting time of the project beyond the 15 MW threshold for small-scale CDM projects.

B.3. Description of the project boundary:

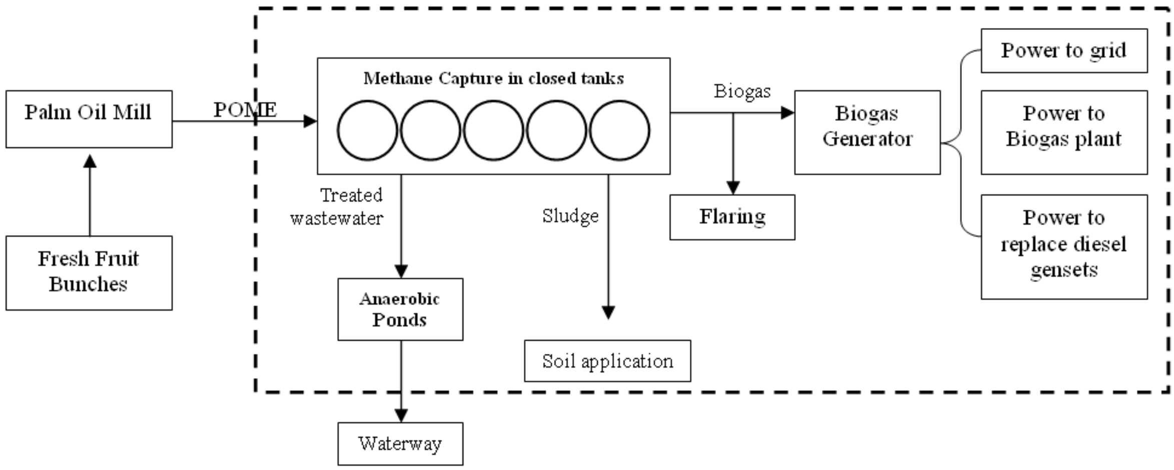
Guided by the stipulated project boundary for Type I and Type III activities in Appendix B for small-scale project activities, the boundary for this project activity encompasses the physical, geographical site where the wastewater and sludge treatment takes place (including electricity generation equipment) and all power plants connected physically to the Peninsula Malaysia Grid.

1. The anaerobic tanks and ponds, where treatment of POME would have continued under the baseline scenario and methane emissions occur in the absence of the proposed biogas plant i.e. in the vicinity of Serting Hilir mill
2. The biogas facility, including the electricity generation component site

3. The plantation sites surrounding the Serting Hilir mill, where the soil application of the produced sludge takes place
4. The Peninsula Malaysian Grid as the system boundary of the project

The project boundary is graphically summarised in the figure below:

Figure 2. Project boundary of the proposed activity.



B.4.	**Description of baseline and its development:**

The baseline emission for the project activity consists of two components, i.e. (1) the methane avoidance component and (2) the electricity generation component.

Methane avoidance component:
Plausible alternative scenarios for the treatment of wastewater (POME) include the following:

M1: The use of open anaerobic tanks and anaerobic ponds for the treatment of the wastewater (baseline scenario);
M2: Direct release of wastewaters to a nearby water body;
M3: Anaerobic digester with methane recovery and utilization for electricity or heat generation (Project Scenario not registered as a CDM Project Activity)

These alternatives are discussed below:

M1: The tank based wastewater technology utilises low-tech tank and pond redundancy to ensure that final releases of wastewater effluent are within regulated limits. It has been the key wastewater treatment method in the palm oil industry the last forty years both in Malaysia[7]. Therefore a considerable body of expertise has been built up in the local workforce to operate and maintain such systems. This technology requires low capital and operational and maintenance costs and is available through local equipment suppliers, operated by local staff and presents no uncertainty or

[7] Ministry of Energy, Water and Communications, PTM, DANIDA (December 2004). Study on Clean Development Mechanism Potential in the Waste Sectors in Malaysia.

perceived risk. This system is also financially attractive, given that it complies with current regulation and requires virtually no additional management or financial input to achieve compliance. Thus, in absence of the project activity, the project owner would continue operating the tank and pond system and releasing methane to the atmosphere, which makes this scenario a plausible and realistic baseline scenario.

M2: Host Country regulations, in particular the Enhancement and Conservation of National Environmental Quality Act of 1974, prohibit the direct release of wastewater into water bodies (rivers, lakes etc). There are no laws in the Host Country that require the use of open pond systems for the treatment which is the business-as-usual practice (BAU scenario). Other technologies such as anaerobic digestion are allowed but are not mandatory in Malaysia. In the case of the Serting Hilir mill, POME is treated in a series of anaerobic tanks and ponds which result in COD removal and, ultimately, the treated water is discharged to a waterway, complying with BOD levels as set up by the Department of Environment. Therefore, under the BAU scenario, there is no need for discharge to a water body. No permit is required for this system (as there is no discharge). The Serting Hilir mill is in full compliance with applicable laws regulations. Therefore, the option of directly releasing wastewater to off-site water ways contravenes the law and therefore is not a plausible and realistic baseline scenario.

M3: This scenario is in compliance with current laws and regulations in Malaysia. However, biogas technologies are novel wastewater management solutions for the palm oil industry in the Host Country[8]. These systems require high up-front investments and entail higher operational and maintenance costs than the anaerobic pond treatment systems. In addition, the performance of these technologies cannot be guaranteed and might result in lower biogas yields. Consecutively, in the case where electricity is produced from biogas, additional revenue from sales of electricity could be negatively affected. The integration of an anaerobic digester system with the production of electricity and the connection to the grid is also not common in Malaysia[9]. Because of the very few examples of utilization of anaerobic digestion technology, there is a lack of technical skills. This affects the construction, operation and maintenance of the project. Considering the above, it is not surprising that investors in the Host Country have a limited understanding of the digester technologies and consider it a high risk investment option. Thus, this scenario is not financially attractive and does not represent a plausible and realistic baseline scenario.

Electricity generation component

The project activity includes electricity generation with biogas from a new anaerobic digester, therefore plausible alternative scenarios for the generation of electricity include the following:

E1: Power generation using fossil fuels in a captive power plant;

E2: Equivalent amount of electricity is supplied by the Peninsula Malaysia Power Grid (baseline scenario)

E3: Electricity generated using biogas and exported to the grid without consideration of CDM revenues.

[8] United Nations Development Programme (UNDP)(2007). Malaysia Generating Renewable Energy from Palm Oil Wastes. Cited at: http://www.energyandenvironment.undp.org/undp/index.cfm?module=Library&page=Document&DocumentID=6451

[9] Ludin *et al*. Palm Oil Biomass for Electricity Generation in Malaysia www.biogen.org.my/bris/BioGen/Tech/(d)Documents/technology(d)7.pdf

These alternatives are discussed below:

E1: Power generation using all fossil fuels (eg diesel) in a captive power plant on the mill's site is capital intensive and will have high operational costs because of current high fuel costs. Such an option is therefore it is not considered a realistic alternative.

E2: This baseline scenario option is in compliance with relevant laws and regulations in the Host Country. It faces neither finance nor other barriers.

E3: This scenario is in compliance with current laws and regulations in the Host Country. However, according to the investment analysis in section B.5, the Project's internal rate of return (IRR) without consideration of CDM revenues is lower than the Project Developer's internal financial benchmark IRR (15%), which represents a severe investment barrier to the Project. Thus, Scenario E3 cannot be considered as the baseline scenario.

Conclusion
From the above analysis it can be conclude that the Scenarios M1 and E2 are the most likely baseline scenarios, as they would face the least barriers. As a result, the baseline scenario of the project can be described as follows: In the absence of the proposed biogas recovery and electricity generation system, biogas would continue to be directly released to the atmosphere from the anaerobic tanks and ponds and electricity would continue to be generated by the mix of power plants connected to the Peninsular Malaysia Power Grid.

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 small-scale CDM project activity:

According to Attachment A of Appendix B of the simplified modalities and procedures for small-scale CDM project activities, additionality is demonstrated by showing that the Project activity would not have occurred without CDM due to the existence of an (a) investment barrier, substantiated by a benchmark analysis and of (b) common practice analysis.

Early consideration of CDM
Prior to development of the project activity the project developer has considered CDM as part of its revenue. This can be proven with the signing of a Letter of Commitment (LOC) dated in 10th of April 2007. A Letter of Acceptance of Offer between the project developer and the technology provider was signed on the 30th of May 2007 and construction at the project site started in September 2007.

a) Investment analysis

The CDM project activity generates financial and economic benefits other than CDM related income, through the export of electricity to the grid; hence the project cannot apply the simple cost analysis. Instead the participants decided to apply benchmark analysis. The likelihood of the development of this Project, as opposed to continued treatment of POME in anaerobic tank and pond systems and import of electricity from the grid (i.e. scenarios M1 and E2 – the baseline) will be determined by comparing the Project IRR without CDM financing (scenarios M3 and E3) with the internal benchmark rate of FELDA Plantations.

The proposed project uses a company internal benchmark IRR as the financial indicator. FELDA views financially viable projects to be those with estimated returns of 15%[10]. This benchmark has been consistently used in the past in similar project activities under similar conditions. Therefore a 15% benchmark for the IRR of this Project applies[11]. The capital requirement for the construction of digesters and the purchase of the gas generators is estimated at and for the biogas system at RM 8,565,844. FELDA is the sole owner of the project. The project has revenues for the sale of electricity to the TNB grid which is expected to be RM 557,000/year for the first 2 years of the project where utilised capacity of 500kWe is installed. The revenue increases to RM 1,145,000/year in year 3 where the utilised capacity of generation is expected to increase to 1,000kWe.

Table 4 below shows the financial analysis for the Serting Hilir project activity, at the time that the decision to go ahead was made, without and with CDM financing. As shown, the project IRR without CDM revenue is negative. The estimated project IRR is improved significantly with carbon financing at 33%, surpassing the cost of capital. The Net Present Value (NPV) of the project activity with and without carbon finance has also been provided, for comparison. As shown in the table below, the NPV without CDM revenues is negative, demonstrating that the project is not an attractive investment. The calculation of NPV uses a 15% discount rate. This therefore indicates that in comparison to other alternative investments, the project was not financially attractive in the absence of CDM financing.

Table 4. Summary of project financial analysis without and with CDM financing.

Financial Analysis Method	without CDM	with CDM
IRR	negative	33%
NPV @ 15% discount rate	($7,659)	$942

Details for calculating the IRR are provided in Table 6.

Sensitivity tests were applied to the cashflow by
1) increasing the revenue from the sales of electricity and saving from diesel fuel by 10% and
2) decreasing the total costs (operational, capital and financial) by 10%.

As shown in Table 5 below, under these test conditions, the project IRR without CDM revenue is still below the benchmark. Table 7 summarises the parameters adopted in the financial analysis for both sites.

Table 5. IRR results of sensitivity analysis (without CDM revenue).

	-10%	0%	+10 %
Total revenue	negative	negative	negative
Operational, capital and financial Costs	negative	negative	negative

Details for calculating the IRR are provided in Table 6.

[10] Documented by internal company documentation made available to the validator.
[11] This correlates with the IRR benchmark of 15% for waste sector projects in Malaysia defined by *DANIDA (2004). Study on Clean Development Mechanism Potential in the Waste Sectors in Malaysia*. Cited at:
http://cdm.eib.org.my/upload/articles1016,article,1154653437,Report_WasteSector_Summary%20report.pdf

These results show that even under very favourable circumstances, the Project IRR was still lower than the benchmark. We can conclude that the Best Case IRR was not financially attractive, and therefore that the Project overall was also not financially attractive. This demonstrates that the Project activity would not be implemented without the CDM.

Table 6. Summary of key parameters used for financial analysis.

Financial Parameters		**Comment**
Electricity tariff (RM/kwh)	0.21	Price as per Power Purchase Agreement
Rate of increase of tariff (%/10 years)	12%	Historical trend in Malaysia[12]
Funded by (Debt to equity ratio)	80:20	Supported by 'BioGen' scheme[13]
Discount rate	15%	FELDA internal benchmark
Depreciation	5%	FELDA depreciation policy
Costs and Equipment (RM)		
Investment (Capex)(RM)	6,780,844 (Phase I)	
	1,785,000 (Phase II)	
Total Investment (RM)	8,565,844	Capital requirement study by project developer
Operating Costs (RM/per annum)	833,000	
Contingencies on OPEX	5%	Considered risky operations as developer have not operated similar plant before

The above project specific analysis results in a similar conclusion about the financial attractiveness of the POME biogas sector in the Host Country as a study by the Ministry of Energy, Water and Communications (December 2004) for POME Biogas projects '*…for power generation options (gas turbines & gas engines), the results indicate the project return becomes attractive from unattractive (less than 15% ROE) with CDM financing. The equity IRR improves from a range of 7-17 % (without CDM) to 17 to 29% (with CDM financing), giving improvement range of 10-12%*'[14].

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[12] Statement to the press by the Minister of Energy, Water and Communications on TNB's tariff review, 24 May 2006 Cited at: http://www.ktak.gov.my/images/YBM's%20Press%20Statement.pdf

[13] BioGen biogas Full Scale Model (FSM) Power Project in Serting Hilir Palm Oil Mill. Cited at: www.biogen.org.my/bris/BioGen/biogas_%20FSM.pdf

[14] The full paragraph is presented here for reference: '***Impact of CDM on Project Financing Viability:*** *For generic POME biogas recovery for energy project, several technical options were analysed. Similar to landfill gas projects, for power generation options (gas turbines & gas engines), the results indicate the project return becomes attractive from unattractive (less than 15% ROE) with CDM financing. The equity IRR improves from a range of 7-17 % (without CDM) to 17 to 29% (with CDM financing), giving improvement range of 10-12%. Similarly, the project IRR also improves with CDM financing especially for the gas engine cogeneration and gas engine power generation options. All the power recovery options are feasible for off-grid connection. However, if grid-connected for SREP, the additional grid connection cost will reduce the attractiveness of the project. Generally, the project IRR and equity IRR are lower. This resulted in only gas engine options are feasible with CDM when grid connected, where ROE improves from 10 and 17% to 24 and 29%. For gas turbine option, only large scale mills seem to be able to be viable with CDM (equity IRR improves from 12% (without CDM) to 26% (with CDM)). Sensitivity analysis based on sizes of palm oil mills indicated that CDM financing in general improves financing for all sizes of mills. However, for such small scale power production, gas turbine option was assessed to be less attractive compared to other options.*' Source: Ministry of Energy, Water and Communications, PTM, DANIDA (December 2004). Study on Clean Development Mechanism Potential in the Waste Sectors in Malaysia (page 10).

b) Common practice analysis

There are around 425 palm oil mills operating in Malaysia[15]. The waste resulting from the processing of FFB will mainly consist of EFB, fiber, shells, and POME. Whilst fiber and shells will normally be used as fuel for the mill boilers to generate heat and electricity for the whole plant, EFB will normally be spread on the plantation (mulching), whilst the POME will be treated in the anaerobic and aerobic ponds or tanks before being applied in the plantation. While open lagoon systems are most commonly used by the Malaysian palm oil industry (about 85% of mills in operation), open tank systems are adopted only by a couple of plantation groups including FELDA Plantations. In terms of number of mills using open tank systems, they constitute probably between 10 to 15%[16].

The utilization of POME to produce biogas which is then flared or combusted to produce heat or electricity is relatively new in Malaysia, so to date only 5 similar facilities (or 1.2 % of the mills) exist under different stages of development:

1. The '*Kim Loong Methane Recovery for Onsite Utilization Project at Kota Tinggi, Johor, Malaysia*' which is also a registered CDM project[17]. This project is using the produced power for internal use rather than exporting electricity to the grid.

2. The *Tennamaram mill at Batang Berjuntai, Selangor*, was the first anaerobic digester tank system in Malaysia with 4 digester tanks producing biogas[18]. However, the project is no longer operational due to technical problems.

3. The '*Tradewinds Methane Extraction and Power Generation Project*' which is submitted as CDM project[19] . This project is using the produced power for internal use rather than exporting electricity to the grid.

4. The '*Tradewinds SerasaBiogas Project*' which is submitted as CDM project[20] . This project is using the produced power for internal use rather than exporting electricity to the grid.

5. The '*KKSL Lekir Biogas Project, Project*' which is submitted as CDM project[21] . This project is using the produced power for internal use rather than exporting electricity to the grid.

As shown above, there is currently no project in the POME biogas sector in the Host Country that is exporting electricity to the grid. Currently, only the proposed project is expected to export electricity to the grid.

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[15] This includes 397 mills in operation; 7 mills not in operation; 21 mills under construction. Source: Malaysian Palm Oil Board, 2006 at www.mpod.gov.my.

[16] Ministry of Energy, Water and Communications, PTM, DANIDA (December 2004). Study on Clean Development Mechanism Potential in the Waste Sectors in Malaysia.

[17] Registered Project 0867: Kim Loong Methane Recovery for Onsite Utilization Project at Kota Tinggi, Johor, Malaysia. Cited at: http://cdm.unfccc.int/Projects/DB/TUEV-SUED1169205863.92/view

[18] Malaysia Energy Centre (PTM). (2000). Feasibility Study on Grid Connected Power Generation Using Biomass Co Generation Technology.

[19] Currently under review, cited at: http://cdm.unfccc.int/Projects/DB/DNV-CUK1186564216.66/view

[20] Currently under validation, cited at: http://cdm.unfccc.int/Projects/Validation/DB/4L2IIIRF04CV9RH76UM2LS82AKCJDB/view.html

[21] Currently under validation, cited at: http://cdm.unfccc.int/Projects/Validation/DB/ART3B7X4AMF641C3QZG72HBJTCOLDJ/view.html

In the past, at the 8th Malaysia Plan (2000-2005), the Host Country had targeted a generation capacity of 5% or 500 MW from renewable energy sources, including biogas. Currently, the Fifth Fuel Policy & 9th Malaysia Plan (2006-2010) has a target of 350 MW of grid connected electricity. However, using biomass and biogas as fuel source for electricity generation in Malaysia only constitute 0.6% of the total electricity demand and below the target of 1.9%[22]. A scheme to promote renewable energy, the Small Renewable Energy Project (SREP) programme has been in place since 2000. The SREP programme had limited success with only 12 MW installed from two projects in the five year period 2000-2005[23]. Overall, the Host Country has an estimated potential of 24PJ of energy or around 320MWe of electricity capacity from POME residues alone[24]. Only a minuscule part of this potential is currently exploited. All the above show that the institutional support to renewable energy grid connected energy projects has yet to deliver in the Host Country.

Conclusion of Additionality Analysis

The analysis presented above shows that the proposed Project faces an investment barrier that would prevent its implementation without the CDM but not the implementation of the relevant alternative scenarios (i.e. scenarios M1 and E2 **–** the continuation of the current situation), which is identified as the baseline scenario. The proposed project activity is therefore additional due to its poor IRR without considering CDM revenue, which is far lower than the benchmark of 15%, and due to the fact that it is not of common activity in the palm oil sector in the Host Country.

B.6. Emission reductions:

B.6.1. Explanation of methodological choices:

1) Methane avoidance component:

Calculation of emission reductions for methane avoidance component of the project activity is in accordance with methodology of AMS III.H. Version 08. The proposed project activity falls under category (vi) of the paragraph 1 of AMS.III.H. which is the*' Introduction of a sequential stage of wastewater treatment with methane recovery and combustion, with or without sludge treatment, to an existing wastewater treatment system without methane recovery'*.

According to Paragraph 26 of AMS III.H., all the equations and calculation based on *COD* value of wastewater in/out of the wastewater treatment system are only for purpose of ex-ante estimation of emission reductions. The calculation of actual emission reductions shall be based on the amount of methane recovered and fuelled or flared, which is monitored ex-post.

1.a) Baseline Emissions

The estimated baseline emissions are the sum of fugitive methane emissions from the existing pond-based water treatment system according to option (vi).

$$\mathbf{BEy = Q_{y,ww} * COD_{y,ww,\ untreated} * B_{o,ww} * MCF_{ww,treatment} * GWP_{CH4}}$$

[22] Statistics of Electricity Supply Industry in Malaysia , 2005 Edition, Energy Commission

[23] Economic Planning Unit, Prime Ministers Department, 2006: Ninth Malaysian Plan 2006-2010.

[24] Ministry of Energy, Water and Communications, PTM, DANIDA (December 2004). Study on Clean Development Mechanism Potential in the Waste Sectors in Malaysia.

where

$Q_{y,ww}$	Volume of wastewater treated in the year "y" (m^3/yr)
$COD_{y,ww,untreated}$	Chemical oxygen demand of the wastewater entering the anaerobic treatment reactor/system with methane capture in the year "y" (tonnes/m^3)
$B_{o,ww}$	Methane producing capacity of the wastewater (IPCC default value of 0.21 kg CH_4/kg COD)[25]
$MCF_{ww,treatment}$	Methane correction factor for the existing wastewater treatment system to which the sequential anaerobic treatment step is being introduced (MCF = 0.8, lower value in Table III.H.1.)
GWP_{CH4}	Global Warming Potential for methane (value of 21 is used)

The key parameters used for the estimation of baseline methane are summarised in Table 7.

Table 7. Parameters used for the estimation of the baseline emissions for the methane component

Parameter	Value	Unit	Rationale
$Q_{y,ww}$	205,222	m^3/yr	Average estimated POME for 2005-7: 205,222 m^3/year
$COD_{y,ww,untreated}$	0.055	tonnes/m^3	COD before entering the digesters will range from 50,000 – 65,000 mg/l. 55,000 used as average.
$B_{o,ww}$	0.21	kg CH_4/kg COD	IPCC default value
$MCF_{ww,treatment}$	0.8	Factor	MCF lower value of table III.H.1 for 'anaerobic reactor without methane recovery wastewater treatment'
GWP_{CH4}	21	tCO_2e / t CH_4	IPCC default value

1.b) Project Emissions

According to AMS III.H, project activity emissions consist of:

(i) CO_2 emissions on account of power used by the project activity facilities. Emission factors for grid electricity or diesel fuel use as the case may be shall be calculated as described in category AMS I.D.;

(ii) Methane emissions on account of inefficiency of the wastewater treatment and presence of degradable organic carbon in treated wastewater;

(iii) Methane emissions from the decay of the final sludge generated by the treatment systems;

(iv) Methane fugitive emissions on account of inefficiencies in capture and flare systems;

(v) Methane emissions resulting from dissolved methane in the treated wastewater effluent.

[25] As per AMS.III.H, the IPCC default value of 0.25 kg CH4/kg COD was corrected to take into account the uncertainties.

(vi) Emissions related to the production, upgrading and use of bottled biogas. If the recovered methane is not upgraded for bottling this term can be neglected.

$$PE_y = PE_{y,power} + PE_{y,ww,treated} + PE_{y,s,final} + PE_{y,fugitive} + PE_{y,dissolved} + PE_{y,bottling}$$

where

PE_y	Project activity emissions in the year "y" (tCO_2e)
$PE_{y,power}$	Emissions from electricity or diesel consumption in the year "y"
$PE_{y,ww,treated}$	Emissions from degradable organic carbon in treated wastewater in year "y"
$PE_{y,s,final}$	Emissions from anaerobic decay of the final sludge produced in the year "y". If the sludge is controlled combusted, disposed in a landfill with methane recovery, or used for soil application, this term can be neglected, and the final disposal of the sludge shall be monitored during the crediting period
$PE_{y,fugitive}$	Emissions from methane release in capture and utilization/combustion/flare systems in year "y"
$PE_{y,dissolved}$	Emissions from dissolved methane in treated wastewater in year "y". Project emissions from this source are only considered for project activities involving measures described in cases (i), (v) and (vi) of paragraph 1
$PE_{y,bottling}$	Emissions related to the production, upgrading and use of the bottled biogas in year "y". This component is not included in the underlying project activity.

Emissions from electricity consumption in the year "y" ($PE_{y,power}$) are calculated as per the procedures described in the 'Tool to calculate the emission factor for an electricity system' which is referred to in AMS.I.D. version 13; the grid emission factor is multiplied by the amount of electricity consumed by the equipment installed in addition to the existing wastewater treatment facility (biogas capture and purification system, electricity generating unit and flare device; including all auxiliary devices):

$$PE_{y,power} = EC_{y,project} * EF_y$$

where

$EC_{y,project}$	the amount of electricity consumed by the equipment installed in addition to the existing wastewater treatment facility (in MWh)
EF_y	the electricity grid emission factor in the year "y"

No fossil fuel (eg diesel) is expected to be used in the implementation of the project activity. Hence, emissions of diesel consumption are considered to be zero here.

The emissions from degradable organic carbon in the treated wastewater ($PE_{y,ww,treated}$) are calculated as follows:

$$PE_{y,ww,treated} = Q_{y,ww} * COD_{y,ww,treated} * B_{o,ww} * MCF_{ww,final} * GWP_{CH4}$$

where

$Q_{y,ww}$	Volume of wastewater treated in the year "y" (m^3/yr)
$COD_{y,ww,treated}$	Chemical oxygen demand of the treated wastewater in the year "y" (tonnes/m^3)
$B_{o,ww}$	Methane producing capacity of the wastewater (IPCC default value of 0.21 kg CH_4/kg COD)[26]
$MCF_{ww,final}$	Methane correction factor based on type of treatment and discharge pathway of the wastewater (as per AMS.III.H, for Phase I a value of 0.3 shall be used for wastewater discharge to anaerobic shallow ponds, depth less than 2 meters; for Phase II a value of 0.1 shall be used for wastewater discharge to aerobic treatment, well managed)
GWP_{CH4}	Global Warming Potential for methane (value of 21 is used)

The proposed project is under category (vi) of paragraph 1 of AMS.III.H. and involves only methane recovery and combustion. In relation to paragraph 26 of AMS.III.H., the proposed activity increases the amount of methane produced per unit of COD removed, compared with the technology used in the baseline[27]. In the baseline, COD values of the treated wastewater after the open tanks range from 10,000 to 15,000 COD mg/l. In the project scenario this will be reduced to 5,000 to 6,500 COD mg/l. Hence, emissions from treated water will be considered to be different from the ones in the baseline scenario (that would be less, because of difference in COD load of the treated water between baseline and project scenarios) and will be deducted in emission reductions in the crediting period.

As per AMS.III.H, emissions from anaerobic decay of the final sludge produced in the year "y" ($PE_{y,s,final}$) can be neglected if the sludge is combusted in a controlled manner, disposed in a landfill with methane recovery or used for soil application. After implementation of the project activity, the sludge produced by the wastewater treatment shall be used for soil application in the plantation around the mill. The proposed project will monitor the final disposal of sludge.

Therefore,

$$\mathbf{PE_{y,s,final} = 0}$$

Sludge disposal shall be monitored throughout the crediting period of the Project.

Fugitive emissions from methane release in capture and flare systems **($PE_{y,fugitive}$)** are defined as follows:

$$\mathbf{PE_{y,fugitive} = PE_{y,fugitive,ww} + PE_{y,fugitive,s}}$$

where

$PE_{y,fugitive,ww}$	Fugitive emissions through capture and utilization/combustion/flare inefficiencies in the anaerobic wastewater treatment in year "y" (tCO_2e);
$PE_{y,fugitive,s}$	Fugitive emissions through capture and ulitization/combustion/flare inefficiencies in the anaerobic sludge treatment in the year "y" (tCO_2e)

[26] As per AMS.III.H, the IPCC default value of 0.25 kg CH4/kg COD was corrected to take into account the uncertainties.
[27] The tanks in the project scenario will be closed and will have mixing mechanisms to maximize methanogenesis.

The second term of the equation above is not applicable because the project activity does not comprise an anaerobic treatment system for sludge; it consists of an anaerobic treatment system for wastewater only.

Hence, the term $PE_{y,fugitive,s}$ is neglected.

The first term of the equation above is calculated as follows:

$$\mathbf{PE_{y,fugitive,ww} = (1 - CFE_{ww}) * MEP_{y,ww,treatment} * GWP_{CH4}}$$

where

CFE_{ww}	Capture and flare efficiency of the methane recovery and combustion equipment in the wastewater treatment (as per AMS.III.H a default value of 0.9 is used for enclosed flare, which is the case in the project activity)
GWP_{CH4}	Global Warming Potential for methane (value of 21 is used)
$MEP_{y,ww,treatment}$	Methane emission potential of the wastewater treatment plant in the year "y" (tonnes), which is calculated according to the equation below:

Regarding the estimation of the CFE_{ww} factor, this is estimated based on the different combustion efficiencies of biogas flared and biogas combusted. Therefore,

$CFE_{ww,\ flaring}$ = 0.90 based on the default efficiency parameter for closed flares

$CFE_{ww,\ combustion}$ = 0.90 based on the combustion efficiency of the biogas engine used in the project.

The methane emission potential of the wastewater treatment plant in the year "y" is estimated as:

$$\mathbf{MEP_{y,ww,treatment} = Q_{y,ww} * COD_{y,ww,untreated} * B_{o,ww} * MCF_{ww,treatment}}$$

where

$Q_{y,ww}$	Volume of wastewater treated in the year "y" (m^3/yr)
$COD_{y,ww,untreated}$	Chemical oxygen demand of the wastewater entering the anaerobic treatment reactor/system with methane capture in the year "y" (tonnes/m3)
$B_{o,ww}$	Methane producing capacity of the wastewater (IPCC default value for domestic wastewater of 0.21 kg CH_4/kg COD)
$MCF_{ww,treatment}$	Methane correction factor for the wastewater treatment system that will be equipped with methane recovery and combustion (as per AMS.III.H a value of 1.0 will be used for anaerobic reactors, which is the case of the project activity).

Emissions from dissolved methane in treated wastewater ($PE_{y,dissolved}$) are calculated as follows:

$$\mathbf{PE_{y,dissolved} = Q_{y,ww} * [CH_4]_{y,ww,treated} * GWP_{CH4}}$$

where

$Q_{y,ww}$	Volume of wastewater treated in the year "y" (m^3/yr)
$[CH_4]_{y,ww,treated}$	Dissolved methane content in the treated wastewater (tonnes/m^3). In aerobic wastewater treatment default value is zero, in anaerobic treatment it can be measured, or a default value of 10e-4 tonnes/m^3 can be used
GWP_{CH4}	Global Warming Potential for methane (value of 21 is used)

In these of the proposed project, in Phase I, the treated water after the digesters will be treated further in shallow anaerobic ponds (less than two meters deep). Therefore, the default value of 10e-4 tonnes/m3 will be used for the first two years of operation. In Phase II, an aerobic tank will be installed and therefore, the default zero value will be used for the remaining 8 years of the crediting period of the project.

Methane captured by the proposed project will be fuelled for electricity generation and occasionally flaring. The proposed project activity does not involve bottling of biogas. Hence, $PE_{y,bottling}$ is neglected.

As a conclusion, in Phase I, Project emissions of the proposed activity will be calculated as:

$$\mathbf{PE_{y,ww,Phase\ I} = PE_{y,power} + PE_{y,fugitive} + PE_{y,\ ww,treated} + PE_{y,dissolved}}$$

while in Phase II as:

$$\mathbf{PE_{y,ww,PhaseII} = PE_{y,power} + PE_{y,fugitive} + PE_{y,\ ww,treated}}$$

<u>1.c) Leakage</u>

As per AMS.III.H leakage effects do not have to be considered since the used technology equipment is not being transferred from or to another activity. The proposed project activity does not involve upgrading and bottling of biogas and no leakage will happen from this part either. Therefore,

$$\mathbf{Leakage_{y,ww} = 0}$$

<u>1.d) Emission reductions</u>

The emission reductions related to methane avoidance in the wastewater treatment process are calculated as the difference between the baseline emissions (Section 1.a above) and the sum of the project emissions (Section 1.b) and leakage (Section 1.c):

$$\mathbf{ER_{y,ww} = BE_{y,ww} - (PE_{y,ww} + Leakage_{y,ww})}$$

The above calculations are for the purposes of the PDD ex-ante only. According to the methodology, ex-post calculation of emission reductions are based on the amount of methane recovered and fuelled and flared, that is monitored as outlined in the monitoring parameter in section B.7.1. Therefore ex-post, baseline emissions determination for the biogas combusted in the biogas engines will be done as follows,

$$\mathbf{BE_y = Q_{y,combustion} * F_{CH4} * D_{CH4} * GWP\_CH4}$$

where

$Q_{y,combustion}$	the amount of biogas fuelled (Nm^3/yr)
F_{CH4}	methane fraction of the recovered biogas (fraction)
D_{CH4}	density of methane ($tonnes/Nm^3$)

For the biogas that is flared, baseline emissions are calculated as follows,

$$\mathbf{BE_y = Q_{y,flaring} * F_{CH4} * D_{CH4} * GWP\_CH4}$$

where

$Q_{y,flaring}$ the amount of biogas flared (Nm^3/yr)

2) Electricity generation component (grid replacement)

2.a) Baseline emissions

According to the methodology AMS-I.D Version 13, which refers to the 'Tool to calculate the emission factor for an electricity system', the baseline emissions for the grid replacement component are the product of the baseline emissions factor ($EF_{y,grid}$ in tCO_2/MWh, based on literature sources[28]), multiplied by the electricity exported to the grid by the project activity ($EG_{y,grid}$) in MWh:

$$\mathbf{BE_{y,grid} = EG_{y,grid} * EF_{y,grid}}$$

The key parameters used for the estimation of baseline methane are summarised in Table 8.

Table 8. Parameters used for the estimation of the baseline emissions for the electricity generation component.

Parameter	Value	Unit	Rationale
$EG_{y,grid, Phase I}$	2,651	MWh/year	Electricity exported to the grid
$EG_{y,grid, Phase II}$	5,454	MWh/year	Electricity exported to the grid
$EF_{y,grid}$	0.620	tCO_2e / MWh	Source: Updated value of Ministry of Energy, Water and Communications, PTM, DANIDA (April 2006). Study on Grid Connected Electricity Baselines in Malaysia.

[28] "Ministry of Energy, Water and Communications, PTM, DANIDA (April 2006). Study on Grid Connected Electricity Baselines in Malaysia.

2.b) Emission Reductions

The electricity generation component of the Project reduces carbon dioxide emissions through displacement of grid electricity generation based on fossil fuel fired power plants by renewable electricity. The emission reduction achieved by the project activity during a given year y is the difference between baseline emissions, project emissions and emissions due to leakage:

$\mathbf{ER_{grid,y} = BE_{grid,y} – (PE_{grid,y} + Leakage_{grid,y})}$

where the baseline emissions are the product of the baseline emissions factor ($EF_{y,grid}$ in tCO_2/MWh, based on literature sources[29]), multiplied by the electricity exported to the grid by the project activity $EG_{y,grid}$ in MWh):

$\mathbf{BE_{y,grid} = EG_{y,grid} * EF_{y,grid}}$

According to the ‘Tool to calculate the emission factor for an electricity system’ project emissions related to electricity generation from this type of project activities are considered to be zero.

Therefore $\mathbf{PE_{y,grid} = 0}$

According to the ‘Tool to calculate the emission factor for an electricity system’, no leakage calculation is required for the proposed project activity.

Therefore, $\mathbf{Leakage_{y,grid} = 0}$

Therefore, the emission reductions related to electricity generation are equal to the baseline emissions, namely:

$\mathbf{ER_{y,grid} = BE_{y,grid} = EG_{y,grid} * EF_{y,grid}}$

3) Electricity generation component (diesel genset replacement)

3.a) Baseline emissions

According to the methodology AMS-I.D Version 13, the baseline emissions for the diesel genset replacement component are the product of the baseline emissions factor ($EF_{y,genset}$ in tCO_2/MWh, based on AMS I.D methodology), multiplied by the electricity actually generated by the diesel genset over the period of last year ($EG_{y,genset}$) in MWh:

$\mathbf{BE_{y,genset} = EG_{y,genset} * EF_{y,genset}}$

The key parameters used for the estimation of baseline methane are summarised in Table 9.

[29] “Ministry of Energy, Water and Communications, PTM, DANIDA (April 2006). Study on Grid Connected Electricity Baselines in Malaysia.

Table 9. Parameters used for the estimation of the baseline emissions for the electricity generation component.

Parameter	Value	Unit	Rationale
$EG_{y,genset}$	362,900	kWh/year	Electricity generated from the diesel gensets (for 2007)
$EF_{y,genset}$	0.8	kg CO_2e / kWh	Source: AMS I.D table I.D.1 Case: i) mini grid with temporary service Load factor: 25% Capacity: >200kW

3.b) Emission Reductions

The electricity generation component of the Project reduces carbon dioxide emissions through displacement of electricity generation based on fossil fuel gensets at the project activity by renewable electricity of the biogas system. The emission reduction achieved by the project activity during a given year y is the difference between baseline emissions, project emissions and emissions due to leakage:

$$\mathbf{ER_{y,genset} = BE_{y,genset} - (PE_{y,genset} + Leakage_{y,genset})}$$

where the baseline emissions are the product of the baseline emissions factor ($EF_{y,genset}$ in kg CO_2/kWh, based on AMS I.D table I.D.1), multiplied by the electricity generated by the diesel genset $EG_{y,genset}$ in kWh):

$$\mathbf{BE_{y,genset} = EG_{y,genset} * EF_{y,genset}}$$

According to the 'Tool to calculate the emission factor for an electricity system' project emissions related to electricity generation from this type of project activities are considered to be zero.

Therefore $\mathbf{PE_{y,genset} = 0}$

According to AMS I.D., no leakage calculation is required for the proposed project activity.

Therefore, $\mathbf{Leakage_{y,genset} = 0}$

Therefore, the emission reductions related to electricity generation are equal to the baseline emissions, namely:

$$\mathbf{ER_{y,genset} = BE_{y,genset} = EG_{y,genset} * EF_{y,genset}}$$

4) Overall emission reductions of the project activity

The overall emission reductions of the project activity are calculated as the sum of the results obtained in Sections 1) and 2) above:

$$\mathbf{ER_{y,total} = ER_{y,ww} + ER_{y,grid} + ER_{y,genset}}$$

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

Data / Parameter:	$\mathbf{B_{o,ww}}$
Data unit:	kg CH_4/kg COD
Description:	Maximum methane producing capacity, expressing the maximum amount of CH_4 that can be produced from a given quantity of chemical oxygen demand (COD).
Source of data used:	IPCC 2006 default value
Value applied:	0.21 kg CH4/kg COD
Justification of the choice of data or description of measurement methods and procedures actually applied :	The default IPCC value for Bo is 0.25 kg CH_4/kg COD. Taking into account the uncertainty of this estimate, project participants should use a value of 0.21 kg CH_4/kg COD as a conservative assumption for Bo.
Any comment:	As per AMS.III.H Version 08, the IPCC default value of 0.25 kg CH4/kg COD was corrected to take into account the uncertainties.

Data / Parameter:	$\mathbf{MCF_{ww,final}}$
Data unit:	Fraction
Description:	methane correction factor based on type of treatment and discharge pathway of the wastewater
Source of data used:	2006 IPCC Guidelines for National Greenhouse Gas Inventories (Volume 5, Chapter 6)
Value applied:	0.3 (Phase I) 0.1 (Phase II)
Justification of the choice of data or description of measurement methods and procedures actually applied :	Phase I: Treated wastewater goes to ponds <2m deep (*anaerobic shallow lagoon* in table III.H.1, MCF Higher values). Phase II: Treated wastewater go for additional aerobic treatment to concrete tank with aerator (*aerobic treatment, well managed* in table III.H.1, MCF Higher Values).
Any comment:	As per AMS.III.H Version 08, the *higher* IPCC value is used for calculation of project emissions as a conservative measure.

Data / Parameter:	$\mathbf{GWP_{CH4}}$
Data unit:	tCO_2e /t CH_4
Description:	Global Warming Potential for methane
Source of data used:	IPCC
Value applied:	21
Justification of the choice of data or description of measurement methods and procedures actually applied :	IPCC default to be applied for the first commitment period.
Any comment:	Shall be updated according to any future COP/MOP decisions.

Data / Parameter:	**$MCF_{ww,treatment}$**
Data unit:	Fraction
Description:	methane correction factor for the wastewater treatment system that will be equipped with methane recovery and combustion
Source of data used:	Table III.H.1. IPCC default values
Value applied:	1.0 (for calculation of project emissions) 0.8 (for calculation of baseline emissions)
Justification of the choice of data or description of measurement methods and procedures actually applied :	Baseline scenario is identified as Anaerobic reactor without methane recovery therefore MCF lower value is 0.8 (used in baseline scenario) and MCF higher value is 1.0 (used for project scenario).
Any comment:	As per AMS.III.H Version 08, the *higher* IPCC value is used for calculation of project emissions and the *lower* value for baseline emissions as a conservative measure.

Data / Parameter:	**$[CH4]_{y,ww,treated}$**
Data unit:	Tonnes/m^3
Description:	Dissolved methane content in the treated wastewater
Source of data used:	Greenfield, P.F. and Batstone, D.J. “Anaerobic digestion: impact of future GHG mitigation policies on methane generation and usage”; Proceedings of Anaerobic Digestion Congress, Montreal, Canada, 2004
Value applied:	Phase I: 10e-4 tonnes/m3 (shallow, anaerobic lagoons) Phase II: 0 (aerobic system)
Justification of the choice of data or description of measurement methods and procedures actually applied :	Recommended default value as per AMS.III.H, Version 08
Any comment:	-

Data / Parameter:	**$EF_{y,genset}$**
Data unit:	kg CO_2e/kWh
Description:	Carbon emission factor for the electricity generated in the mill’s gensets displaced by the electricity generated from the biogas in year y
Source of data used:	Data obtained from table I.D.1 of AMS I.D v013
Value applied:	0.8
Justification of the choice of data or description of measurement methods and procedures actually applied :	AMS I.D.v013 methodology Table I.D.1. Case: i) mini grid with temporary service Load factor: 25% Capacity: >200kW
Any comment:	-

Data / Parameter:	$EF_{y,grid}$
Data unit:	t CO_2e/MWh
Description:	Carbon emission factor for the grid electricity (Peninsula Malaysia Grid) displaced by the electricity generated from the biogas in year y
Source of data used:	Data obtained from the Danida/PTM study titled: "Study on Grid Connected Electricity Baselines in Malaysia". Available online at http://cdm.ptm.org.my/upload/articles1016,article,1151393608,CDM_Baseline_Malaysia.pdf
Value applied:	0.620
Justification of the choice of data or description of measurement methods and procedures actually applied :	Study proposed 0.631 t CO_2e/MWh value but recent guidance from the responsible Government agency recommends 0.620 t CO_2e/MWh for small scale projects.
Any comment:	-

Data / Parameter:	**Flare efficiency**
Data unit:	%
Description:	Flare efficiency for closed flare
Source of data used:	Tool to determine project emissions from flaring gases containing methane
Value applied:	90%
Justification of the choice of data or description of measurement methods and procedures actually applied :	The Project activity has an enclosed flare therefore the 90% default from the flare tool was used.
Any comment:	Used for the estimation of $CFE_{ww,\ flaring}$

Data / Parameter:	**Biogas engine combustion efficiency**
Data unit:	%
Description:	Combustion efficiency of the biogas engine
Source of data used:	Technology provider
Value applied:	90%
Justification of the choice of data or description of measurement methods and procedures actually applied :	Technology provider
Any comment:	Used for the estimation of $CFE_{ww,\ combustion}$

Data / Parameter:	D_{CH4}
Data unit:	tCH_4/m_3CH_4
Description:	Density of methane
Source of data to be used:	ACM0001 version 08.

Value of data	0.0007168
Description of measurement methods and procedures to be applied:	ACM0001 version 08.
QA/QC procedures to be applied:	-
Any comment:	At standard temperature and pressure (0 degree Celsius and 1,013 bar)

B.6.3 Ex-ante calculation of emission reductions:

1) Methane avoidance component:

1.a) Baseline Emissions

The estimated baseline emissions are the sum of fugitive methane emissions from the existing pond-based water treatment system according to option (vi).

$$\mathbf{BEy = Q_{y,ww} * COD_{y,ww,\ untreated} * B_{o,ww} * MCF_{ww,treatment} * GWP_{CH4}}$$

where

Parameter	Value	Unit	Comment
BE_y	39,821	tCO_2e	
$Q_{y,ww}$	205,222	$m^3/year$	
$COD_{y,ww,untreated}$	0.055	ton/m^3	
$B_{o,ww}$	0.21	$kgCH_4/kgCOD$	
$MCF_{ww,treatment}$	0.8		
GWP_CH_4	21	$tonCO_2/tonCH_4$	

Therefore, **BEy = 39,821 tCO_2e.**

1.b) Project Emissions

The project emissions of the proposed project are calculated based on:

$$\mathbf{PE_y = PE_{y,power} + PE_{y,ww,treated} + PE_{y,fugitive} + PE_{y,dissolved}}$$

Therefore, the emissions from degradable organic carbon in the treated wastewater ($PE_{y,ww,treated}$) are calculated as follows:

$$\mathbf{PE_{y,ww,treated} = Q_{y,ww} * COD_{y,ww,treated} * B_{o,ww} * MCF_{ww,final} * GWP_{CH4}}$$

where for Phase I it is

Parameter	Value	Unit	Comment
$PE_{y,ww,treated}$	1,493	tCO_2e	
$Q_{y,ww}$	205,222	m^3/year	
$COD_{y,ww,treated}$	0.0055	ton/m^3	
$B_{o,ww}$	0.21	$kgCH_4$/kgCOD	IPCC
$MCF_{ww,final}$	0.3		IPCC
GWP_CH_4	21	$tonCO_2/tonCH_4$	

And for Phase II is

Parameter	Value	Unit	Comment
$PE_{y,ww,treated}$	498	tCO_2e	
$Q_{y,ww}$	205,222	m^3/year	
$COD_{y,ww,treated}$	0.0055	ton/m^3	
$B_{o,ww}$	0.21	$kgCH_4$/kgCOD	IPCC
$MCF_{ww,final}$	0.1		IPCC
GWP_CH_4	21	$tonCO_2/tonCH_4$	

Fugitive emissions from methane release in capture and flare systems **($PE_{y,fugitive}$)** are defined as follows:

$$\mathbf{PE_{y,fugitive,ww} = (1 - CFE_{ww}) * MEP_{y,ww,treatment} * GWP_{CH4}}$$

Where, for both Phase I and Phase II is

Parameter	Value	Unit	Comment
$PE_{y,fugitive,ww}$	4,978	tCO_2e	
CFE_{ww}	0.90		
$MEP_{y,ww,treatment}$	2,370		
GWP_CH_4	21	$tonCO_2/tonCH_4$	

In the above, **$MEP_{y,ww,treatment}$** is calculated based on:

$$\mathbf{MEP_{y,ww,treatment} = Q_{y,ww} * COD_{y,ww,untreated} * B_{o,ww} * MCF_{ww,treatment}}$$

Where for both Phase I and Phase II is:

Parameter	Value	Unit	Comment
$MEP_{y,ww,treatment}$	2,370		
$Q_{y,ww}$	205,222	m^3/year	
$COD_{y,ww,untreated}$	0.0550	ton/m^3	
$B_{o,ww}$	0.21	$kgCH_4$/kgCOD	IPCC

$MCF_{ww,treatment}$	1	IPCC

Emissions from dissolved methane in treated wastewater ($PE_{y,dissolved}$) are calculated as follows:

$$\mathbf{PE_{y,dissolved} = Q_{y,ww} * [CH_4]_{y,ww,treated} * GWP_{CH4}}$$

Where for Phase I it is

Parameter	Value	Unit	Comment
$PE_{y,dissolved}$	431	tCO_2e	
$Q_{y,ww}$	205,222	m^3/year	
$[CH_4]_{y,ww,treated}$	0.0001		
GWP_CH_4	21	$tonCO_2/tonCH_4$	

And for Phase II it is

Parameter	Value	Unit	Comment
$PE_{y,dissolved}$	0	tCO_2e	
$Q_{y,ww}$	205,222	m^3/year	
$[CH_4]_{y,ww,treated}$	0.0000		Aerobic treatment in phase II
GWP_CH_4	21	$tonCO_2/tonCH_4$	

As a conclusion, total project emissions of the proposed activity are:

For Phase I:

Parameter	Value	Unit	Comment
PE_y	6,902	tCO_2e	
$PE_{y,power}$	0	tCO_2e	Plant power by biogas electricity
$PE_{y,ww,treated}$	1,493	tCO_2e	
$PE_{y,s,final}$	0	tCO_2e	
$PE_{y,fugitive}$	4,978	tCO_2e	
$PE_{y,dissolved}$	431	tCO_2e	

For Phase II:

Parameter	Value	Unit	Comment
PE_y	5,475	tCO_2e	
$PE_{y,power}$	0	tCO_2e	Plant power by biogas electricity
$PE_{y,ww,treated}$	498	tCO_2e	

$PE_{y,s,final}$	0	tCO_2e	
$PE_{y,fugitive}$	4,978	tCO_2e	
$PE_{y,dissolved}$	0	tCO_2e	

1.c) Leakage

$Leakage_{y,ww} = 0$

1.d) Emission reductions

The emission reductions related to methane avoidance in the wastewater treatment process are calculated as below:

$ER_{y,ww} = BE_{y,ww} – (PE_{y,ww} + Leakage_{y,ww})$

Where for Phase I it is

Parameter	Value	Unit	Comment
$ER_{y,ww}$	32,919	tCO_2e	
$Leakage_{y,ww}$	0	tCO_2e	
$PE_{y,ww}$	6,902	tCO_2e	
$BE_{y,ww}$	39,821	tCO_2e	

and for Phase II

Parameter	Value	Unit	Comment
$ER_{y,ww}$	34,346	tCO_2e	
$Leakage_{y,ww}$	0	tCO_2e	
$PE_{y,ww}$	5,475	tCO_2e	
$BE_{y,ww}$	39,821	tCO_2e	

2) Electricity generation component (grid replacement)

2.a) Baseline emissions

According to the methodology AMS-I.D Version 13, the baseline emissions of the electricity generation component of the Project are defined as the amount of kWh produced by the renewable generating unit and exported to the grid, multiplied by the baseline emission factor ($EF_{y,grid}$).

$BE_{y,grid} = EG_{y,grid} * EF_{y,grid}$

Therefore, for Phase I it will be:

Parameter	Value	Unit	Comment
$BE_{y,grid}$	1,643	tCO_2e	
$EG_{y,grid}$	2,651	MWh/year	
$EF_{y,grid}$	0.620	tCO_2e / MWh	

And for Phase II it will be:

Parameter	Value	Unit	Comment
$BE_{y,grid}$	3,381	tCO_2e	
$EG_{y,grid}$	5,454	MWh/year	
$EF_{y,grid}$	0.620	tCO_2e / MWh	

2.b) Emission Reductions

The emission reductions related to electricity generation are equal to the baseline emissions, namely:

$$\mathbf{ER_{y,grid} = BE_{y,grid} = EG_{y,grid} * EF_{y,grid}}$$

Therefore,

Phase I: $ER_{y,grid} = BE_{y,grid} = 1,643\ tCO_2e$
Phase II: $ER_{y,grid} = BE_{y,grid} = 3,381\ tCO_2e$

3) Electricity generation component (diesel genset replacement)

3.a) Baseline emissions

According to the methodology AMS-I.D Version 13 this would be

$$\mathbf{BE_{y,genset} = EG_{y,genset} * EF_{y,genset}}$$

Therefore this will be:

Parameter	Value	Unit	Comment
$\mathbf{BE_{y,genset}}$	290	tCO_2e	
$EG_{y,genset}$	362,900	kWh/year	Electricity generated from the diesel gensets (for 2007)

$EF_{y,genset}$	0.8	kg CO_2e / kWh	Source: AMS I.D table I.D.1 Case: i) mini grid with temporary service Load factor: 25% Capacity: >200kW

3.b) Emission Reductions

Emissions reductions are estimated as

$\mathbf{ER_{y,genset} = BE_{y,genset} - (PE_{y,genset} + Leakage_{y,genset})}$

where $\mathbf{PE_{y,genset} = 0}$ and $\mathbf{Leakage_{y,genset} = 0}$

Therefore, the emission reductions related to electricity generation are equal to the baseline emissions, namely:

$\mathbf{ER_{y,genset} = BE_{y,genset}}$

Therefore, $\mathbf{ER_{y,genset}}$ = 290 tCO_2e.

4) Overall emission reductions of the project activity

The overall emission reductions of the project activity are calculated as:

$\mathbf{ER_{y,total} = ER_{y,ww} + ER_{y,grid} + ER_{y,genset}}$

Therefore for Phase I

Parameter	Value	Unit	Comment
$\mathbf{ER_{y,total}}$	34,852	tCO_2e	
$\mathbf{ER_{y,ww}}$	32,919	tCO_2e	
$\mathbf{ER_{y,grid}}$	1,643	tCO_2e	
$\mathbf{ER_{y,genset}}$	290	tCO_2e	

and for Phase II

Parameter	Value	Unit	Comment
$\mathbf{ER_{y,total}}$	38,017	tCO_2e	
$\mathbf{ER_{y,ww}}$	34,346	tCO_2e	
$\mathbf{ER_{y,grid}}$	3,381	tCO_2e	

$ER_{y,genset}$	290	tCO_2e

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

Years	**Estimation of baseline emissions (tonnes of CO_2 e)**	**Estimation of project activity emissions (tonnes of CO_2e)**	**Estimation of leakage (tonnes of CO_2 e)**	**Estimation of emission reductions (tonnes of CO_2 e)**
2008 (Sept - Dec)	13,918	2,301	0	11,618
2009	41,755	6,902	0	34,853
2010	42,334	6,426	0	35,908
2011	43,493	5,475	0	38,017
2012	43,493	5,475	0	38,017
2013	43,493	5,475	0	38,017
2014	43,493	5,475	0	38,017
2015	43,493	5,475	0	38,017
2016	43,493	5,475	0	38,017
2017	43,493	5,475	0	38,017
2018 (Jan-Aug)	28,995	3,650	0	25,345
Total (tonnes of CO_2)	271,979	37,531	0	373,846

B.7.1 Data and parameters monitored:

Data / Parameter:	**$Q_{y,ww}$**
Data unit:	m^3
Description:	Volume of wastewater treated in the year "y"
Source of data to be used:	Project developer
Value of data	205,222
Description of measurement methods and procedures to be applied:	Measured by a flow meter and recorded weekly. Estimate value derived from 2005-7 average: 205,222 m^3/yr
QA/QC procedures to be applied:	Meter will be maintained and calibrated periodically in accordance with manufacturer's recommendations
Any comment:	-

Data / Parameter:	**$COD_{y,ww,untreated}$**
Data unit:	tonnes/m^3
Description:	Chemical oxygen demand of the wastewater entering the anaerobic treatment

	reactor/system with methane capture in the year "y"
Source of data to be used:	Project developer
Value of data	0.055
Description of measurement methods and procedures to be applied:	COD will be sampled and analysed on site weekly.
QA/QC procedures to be applied:	-
Any comment:	-

Data / Parameter:	**$COD_{y,ww,treated}$**
Data unit:	tonnes/m^3
Description:	Chemical oxygen demand of the treated wastewater in the year "y"
Source of data to be used:	Project developer
Value of data	0.0055
Description of measurement methods and procedures to be applied:	COD will be sampled and analysed on site weekly.
QA/QC procedures to be applied:	-
Any comment:	-

Data / Parameter:	**$Q_{y,combustion}$**
Data unit:	Nm^3
Description:	Amount of biogas combusted in gas engine
Source of data to be used:	Project developer
Value of data	Phase I: 3,570,348 (60% of biogas combusted) Phase II: 5,653,050 (95% of biogas combusted)
Description of measurement methods and procedures to be applied:	Measurements will be done using a flow meter which automatically measures temperature and pressure, displaying flow in Nm^3. Data will be recorded weekly.
QA/QC procedures to be applied:	Flow meters will be subject to regular repair maintenance and calibration according to manufacturer's guidelines.
Any comment:	-

Data / Parameter:	**$Q_{y,flaring}$**
Data unit:	Nm^3
Description:	Amount of biogas flared (if any)
Source of data to be used:	Project developer
Value of data	Phase I: 2,380,232 (40% of biogas flared)

	Phase II: 297,529 (5% of biogas flared)
Description of measurement methods and procedures to be applied:	Measurements will be done using a flow meter which automatically measures temperature and pressure, displaying flow in Nm^3. Data will be recorded weekly.
QA/QC procedures to be applied:	Flow meters will be subject to regular repair maintenance and calibration according to manufacturer's guidelines.
Any comment:	-

Data / Parameter:	**F_{CH4}**
Data unit:	%
Description:	Methane concentration of biogas
Source of data to be used:	Project developer (estimated)
Value of data	50%
Description of measurement methods and procedures to be applied:	Measured with a continuous analyser or with periodical measurements at a 95% confidence level.
QA/QC procedures to be applied:	Equipment will be maintained and calibrated in line with manufacturer's recommendations.
Any comment:	-

Data / Parameter:	**$EG_{y,grid}$**
Data unit:	MWh/year
Description:	Net amount of electricity exported to the grid in the year "y"
Source of data to be used:	Project developer
Value of data	Phase I: 2,651 Phase II: 5,454
Description of measurement methods and procedures to be applied:	Measured continuously by an electricity meter at the grid connection point (operated by the grid operator).
QA/QC procedures to be applied:	-
Any comment:	-

Data / Parameter:	**$EG_{y,genset}$**
Data unit:	MWh/year
Description:	Net amount of electricity used in the mill to replace diesel genset in the year "y"
Source of data to be used:	Project developer
Value of data	363
Description of measurement methods	Measured continuously by an electricity meter at the project site (operated by the mill)

and procedures to be applied:	
QA/QC procedures to be applied:	-
Any comment:	-

Data / Parameter:	Final disposal of sludge
Data unit:	N/A
Description:	Application of sludge on soils
Source of data to be used:	Project developer.
Value of data	N/A
Description of measurement methods and procedures to be applied:	For the proposed project, the final sludge will be used for soil application in the smallholder plantations around the Serting Hilir mill. Dried sludge from the sludge pits will be collected by smallholder farmers to be applied to their land.
QA/QC procedures to be applied:	-
Any comment:	-

Data / Parameter:	T_{flare}
Data unit:	°C
Description:	Temperature in the exhaust gas of the flare
Source of data to be used:	Project developer
Value of data	Higher than 500°C
Description of measurement methods and procedures to be applied:	The flare is expected to operate according to the manufacturer's specifications.
QA/QC procedures to be applied:	-
Any comment:	-

B.7.2 Description of the monitoring plan:

The monitoring plan details the actions necessary to record all the data parameters required by the methodology AMS III.H, version 08, as detailed in section B.7.1.

The Monitoring Plan for this project has been developed to ensure that from the start, the project is well organised in terms of the collection and archiving of complete and reliable data.

CDM monitoring organisation and management

Prior to the start of the crediting period, the organisation of the monitoring team will be finalised. Clear roles and responsibilities will be assigned to all staff involved in the CDM project. The Project Developer will have a designated CDM monitoring manager on site who will be responsible for monitoring emissions reductions of the project activity. All staff involved in the collection of data and records will be coordinated by him.

Data collection and record keeping arrangements:
Data monitored for CDM purposes will be recorded at the appropriate frequency. The CDM monitoring manager will be responsible for managing the collection, storage and archiving of all data and records. All relevant data will be archived electronically, and backed up regularly. All data required for verification and issuance will be kept for at least two years after the end of the crediting period or the last issuance of CERs of this project, whichever occurs later.

Data Quality Control and Quality Assurance
All data collected will be checked by the CDM monitoring manager. The CDM monitoring manager reports to the Mill manager, who has the overall quality control. The Mill manager reports to the FELDA Headquarters CDM manager that oversees CDM projects in the FELDA mills and also checks for anomalies or other monitoring issues before forwarding data to EcoSecurities.

EcoSecurities will perform a regular final check of the data and analyse project performance prior to any verification. Moreover, regular internal audits will be conducted to assure that the project is in compliance with operational and CDM requirements.

Procedures will be developed to deal with possible monitoring data adjustments and uncertainties as well as emergencies.

Maintenance and Calibration of monitoring equipment
All equipment will be maintained and calibrated in line with manufacturer's recommendations and according to a pre-set schedule. This will assure that the equipment operates at the stated level of accuracy.

Staff training
Training is conducted on site at regular intervals to ensure that staff is capable to perform their designated tasks at high standards. This will include CDM specific training to warrant that they understand the importance of complete and accurate data and records for CDM monitoring.

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

Date of completion: 21 February 2008.
Prepared by: Nick Stantzos
EcoSecurities Malaysia Sdn Bhd
Northpoint Office Suite, Mid Valley City
No 1 Medan Syed Putra Utara, 59200 Kuala Lumpur
Tel: +60 (03) 2282 0612
Email: nick.stantzos@ecosecurities.com

EcoSecurities is the CDM advisor to the Project and is also a project participant. The contact details of the above entity determining the baseline is listed in Annex I.

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:

22/05/2007

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

25 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:

01/09/08 or the date of registration of the Project, whichever is later.

C.2.2.2. Length:

Ten (10) year, zero (0) months.

SECTION D. Environmental impacts

D.1. If required by the host Party, documentation on the analysis of the environmental impacts of the project activity:

No Environmental Impact Assessment (EIA) has been conducted as it is not required by Host Country legislation. According to Malaysian EIA legislation no EIA is required for projects generating electricity from biomass sources and are below 10MW capacity[30]. The Project activity complies with all local and

[30] Environmental Impact Assessment (EIA) in Malaysia is the Environmental Quality Order of 1987 based on the Environment Quality Act of 1974. Order12.

national regulations related to establishment and operation of waste-water treatment. The Serting Hilir mill has permission from the Department of the Environment for the discharge of treated wastewater to waterways and a SREP (Small Renewable Energy Programme) Commission Approval for the generation of electricity from biogas.

Environmental *impacts* of the project include:

1. **Leachate** –Risk of POME leakage is very limited because the site has been designed as a closed system.

2. **Electricity consumption –** Any additional electricity will be provided from the unused biogas genset, therefore there are no emissions.

3. **Noise** – Noise nuisance will be very limited as the genset will be housed and located some distance from any houses.

4. **Biogas leakage** – Risk of biogas leakage is very limited because of closing of the anaerobic tanks.

Environmental *benefits* of the project include:

1. **Water quality** – Improved water quality through the decrease of COD of waste water from the new treatment system

2. **Reduction of Greenhouse Gases** – The Project will reduce the green house gas emissions by avoiding the released of methane from waste water treatment system (tanks) and by reduction of the demand for fossil fuel based grid electricity

3. **Odour nuisance** – Odour nuisance from the anaerobic lagoons will be reduced as POME will not be treated anymore in open lagoons

4. **Land** – Reduces the current practice of huge area for POME treatment.

Overall, the proposed Project activity will reduce the environmental impact of the mill's activities and will contribute to the sustainability of the palm oil industry as defined at the "Roundtable on sustainable palm oil-RSPO"[31]. FELDA Plantations is a full member of the RSPO and has been working towards applying the RSPO Criteria at its operations[32].

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:

[31] In the categories 1) Waste management: reduced and reused and 3) Reduction of pollution and greenhouse gases.

[32] A report of FELDA's activities regarding RSPO could be found at: http://www.rspo.org/resource_centre/21_12_2007_03_58_34FELDA.pdf

No significant negative environmental impacts have been identified. In both the baseline and in project case, the Serting Hilir mill has a permission to release treated wastewater to waterways. The main solid waste is the dried sludge generated from the digesters, with or without the methane recovery project, which is used as fertilizer, as in the baseline.

SECTION E. Stakeholders' comments

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

The Stakeholders Consultation was held on the 16th of August 2007 at FELDA Serting Hilir Homestay, Negeri Sembilan. Letters of invitation were sent out to stakeholders (local authorities, Department of Environment, local communities, NGOs etc) and published in two languages in the local newspapers two weeks before the Stakeholders Consultation.

The meeting commenced with a welcoming speech by FELDA's CDM Project Coordinator, Mr Zainuri Busu, giving the background of the mill, details of the mill operations and an introduction to the FELDA Serting Hilir Biogas Plant Project.

The presentation was followed by a briefing on Clean Development Mechanism and the sustainable development benefits of FELDA Serting Hilir Biogas Project by Ms Nik Fadzrina Hussain of EcoSecurities, Malaysia.

Attendees were 32 in total, which includes the representatives of the Department of Environment, Pusat Tenaga Malaysia, members of the public and the technology provider.

After the presentation, an open forum was carried out to elicit comments and issues from the various stakeholders.

E.2. Summary of the comments received:

Some concerns relating to the project were raised by the Stakeholders. These are summarised below:

1. Prof Mohd Ali Hassan, Universiti Pertanian Malaysia (UPM): How is the technology transfer affected in this project? Will FELDA be able to replicate the biogas plant model to other plantations or will FELDA need to get the technology provider involved again for future projects?
   Answered by Zainuri of FELDA: Technology is provided by CST Engineering, a Danish company. In the development process of designing and constructing the plant, FELDA has been involved closely with CST Engineering. The design and construction started with a pilot plant which has proved to be working well and now FELDA is moving on to a full scale size plant, able to treat all the effluent from the Serting Hilir mill and trap the released gasses for electricity generation.

2. Mr Abdul Khalid Mat, Jempol Land Office: Will there be new jobs created resulting from the implementation of this project? Please ensure that the locals are not given only menial jobs to do.
   Answered by Zainuri of FELDA: Yes, there will be new jobs created. Priority will be given to the locals with suitable qualification and skills.
   Comments by Prof Ali of UPM: The CDM concept should benefit the 3P of profit, people and planet. Apart from the job creation from this project, there will be job creation from new industries that will

crop up now that there is available excess electricity in the area. There can also be new related industries such as fertilizer plant.

3. Ms Norlin Jaafar, Department of Environment: What is the capacity of the biogas power plant? How much will be supplied to the grid?
   Answered by Zainuri of FELDA: The biogas power plant is estimated to generate 1000kWh but the amount of biogas available can actually generate up to 1.2MWh. Once this biogas plant is running well, FELDA might increase the capacity further to 1.2MW. FELDA is currently evaluating whether to supply the electricity to the grid or use it fully at the mill.

4. Mr Ahmad Zairin of Pusat Tenaga Malaysia: The government is encouraging the implementation of renewable energy projects. Since year 2001, renewable energy is one of the five targeted national fuel source. Biomass is the key renewable energy source identified, but the use of fuel from other wastes such as POME is also encouraged. Domestic wastes in developed countries have been used to generate heat and electricity.

5. Ms Norlin Jaafar of Department of Environment: Has the financial feasibility of the biogas project analysed?
   Answered by Zainuri of FELDA: Yes and it is found to be feasible only with the help of CDM revenue.

6. Serting Hilir Settler: Is there any monetary incentive channelled back to the settlers from the CDM revenue?
   FELDA will evaluate the feasibility of sharing the CDM revenue with FELDA settlers. However, please bear in mind that there is a cost to run the biogas plant and there may not be a lot of surplus revenue once all the maintenance and operating cost is taken into consideration.
   Mr Aziz, Finance Executive, FELDA: Projects such as the biogas plant will improve overall infrastructure for FELDA mills. This will lead to increased efficiency at the mills and higher profits for FELDA as a whole. The shareholders of FELDA which are the settlers will receive the direct monetary benefit in the form of higher dividends.

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

As shown in Section E.2, the Project Activity received positive comments which led to no changes of the initial project planning.

Annex 1

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Annex 2

INFORMATION REGARDING PUBLIC FUNDING

This project will not receive any public funding from Annex 1 parties.

Annex 3

BASELINE INFORMATION

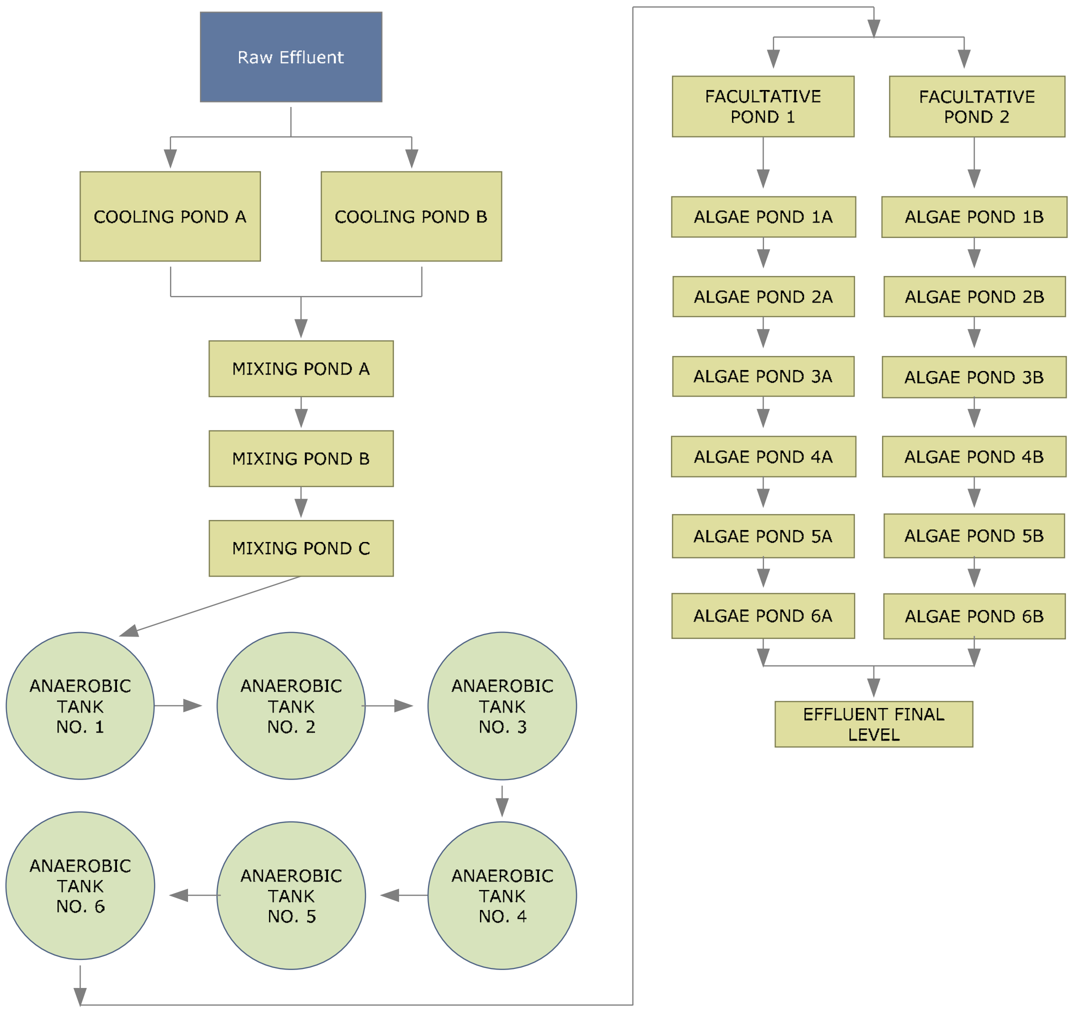
Table 10. Historical data of FFB processed and POME generated at Serting Hilir mill.

	2005		2006		2007	
	FFB Processed [MT]	POME [m^3]	FFB Processed [MT]	POME [m^3]	FFB Processed [MT]	POME [m^3]
Jan	27,300	19,481	11,250	8,028	18,040	12,873
Feb	23,100	16,484	17,610	12,566	16,570	11,824
Mar	28,690	20,473	22,140	15,799	18,730	13,366
Apr	31,000	22,122	30,900	22,050	18,680	13,330
May	31,000	22,122	34,400	24,548	19,340	13,801
Jun	22,660	16,170	33,000	23,549	18,820	13,430
Jul	27,660	19,738	35,700	25,476	22,340	15,942
Aug	24,130	17,219	31,780	22,678	20,060	14,315
Sep	24,320	17,355	27,000	19,267	26,560	18,953
Oct	21,290	15,193	19,000	13,558	28,190	20,116
Nov	16,550	11,810	24,100	17,198	31,370	22,386
Dec	9,960	7,107	18,640	13,302	30,880	22,036

Table 11. Description of baseline POME treatment system at Serting Hilir mill.

ITEM	No.OF UNITS	TOTAL RETENTION TIME (DAYS)	SIZE			CAPACITY (tonnes)	HECTARES
			LENGTH (M)	WIDTH (M)	DEPTH (M)		
COOLING PONDS	2	-	29	29	1.5	2800	0.17
MIXING PONDS	3	6	39	39	1.5	7000	0.45
ANAEROBICS TANKS	6	11	6 x 3600m3 tanks	-	-	21600	-
FACULTATIVE PONDS	2	35	160	58	2.5	46000	1.89
ALGAE PONDS NO.2	2	36	180	85	1.2	36700	3.06
ALGAE PONDS NO.3	2	36	180	85	1.2	36700	3.06
ALGAE PONDS NO.4	2	36	180	85	1.2	36700	3.06
ALGAE PONDS NO.5	2	36	180	85	1.2	36700	3.06
ALGAE PONDS NO.6	2	36	180	85	1.2	36700	3.06

Figure 3. Diagram of baseline POME treatment system at Serting Hilir mill.



Annex 4

MONITORING INFORMATION

Please refer to sections B7.1. and 7.2 above.