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

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Annexes

SECTION A. General description of project activity

A.1 Title of the project activity:

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Power generation with waste materials and recovered gas of palm oil mill in Selangau, Malaysia
ACM0006 Version 06.2 and ACM0014 Version 02.1, February 20, 2009

A.2. Description of the project activity:

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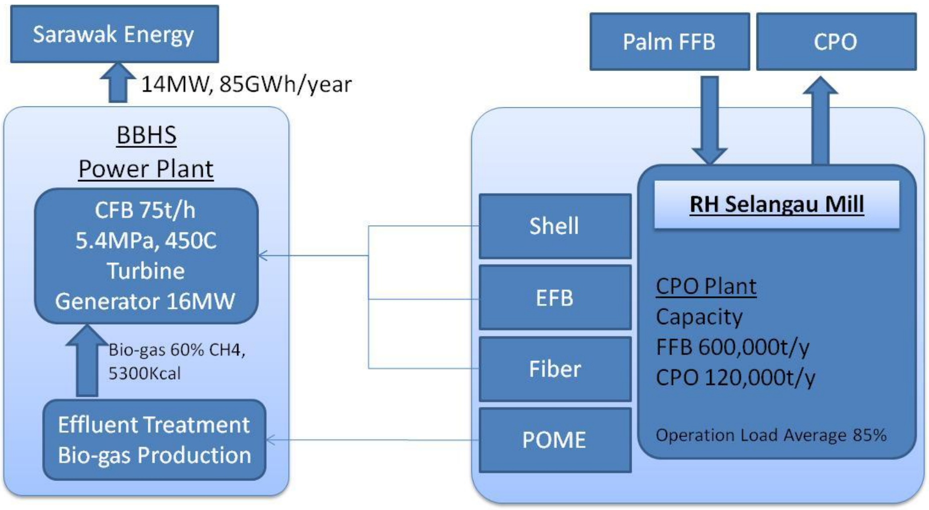
A.2.1. Purpose of the Project Activity

The project activity involves the installation of a Circulated Fluidized Bed (CFB) boiler to utilize discarded waste at Rimbunan Sawait's Selangau Mill. The plant will utilize biomass residues and recover methane gas from Palm Oil Mill Effluent (POME). Steam and electricity are generated by the combustion of the biomass residues. The electricity which will not be consumed in situ will be transferred to the Sarawak Energy's grid line. This will reduce the grid system's dependency on fossil fuel resources and as such helps addressing global warming issues. The plant will be able to utilise waste products from the milling process such as fibres, shells and Empty Fruit Bunches (EFB). The project activity would avoid methane emission from the decay of the discarded EFB and methane emission from anaerobic processing of POME in the open lagoons.



A.2.2. Contribution to the sustainable development of the host country

The project contributes to the sustainable development of Malaysia as follows:

1) Utilization of EFB

The Malaysian federal government outlined in its 9th development plan regarding the diversification of energy sources with a focus on unused biomass materials. The proposed project is consistent with this energy policy.

2) Provision of renewable energy

Echoing the Malaysian federal plan, the Sarawak state government announced the Sarawak Corridor of Renewable Energy (SCORE) to encourage the development of renewable energy sources. Beyond the fact that a renewable energy source will be offered, our project will also permit to utilize much of the organic waste, which has been so far discarded. The proposed hybrid system will optimize the energy production from the palm oil mill's biomass waste material.

3) Technology transfer for better use of biomass

This project involves the transfer of skills for both the operation of the power generation plant and the optimization of the energy production from the palm oil mill's biomass waste material.

Thus, it appears that this CDM project is in line with both the Malaysian Federal and the State Government's policies, which aim to promote country's sustainable development.

A.2.3. Project plans

Palm oil industry yields a large amount of waste residues through its operations. The main types of waste are: EFB and POME. These materials produced by palm oil mills are traditionally discarded in the field without any prior treatment or discharged to the river system without any recovery of biogas. EFB are combustible and can generate power and steam. EFB has been regarded as a potential source of energy for a while, but handling difficulties, especially with regard to the potassium in the combustion room, have so far prevented it from being reliable biomass fuel.

A.2.3.1 EFB treatment process

Palm oil mills in Malaysia have traditionally used part of their EFB waste to generate steam via combustion. However, it appears that the high content of potassium accumulated through palm fertilizer has constantly created problems during the combustion process: the potassium is clogged in the chamber and it reduces combustion efficiency significantly. To avoid this potential problem, the project proposes to treat EFB prior to the combustion. Such a treatment drastically reduces potassium content of the EFB. This pre-combustion treatment appears suitable for palm oil mills to attain higher boiler efficiency and achieve long-term economic viability.

A.2.3.2 Power generation

Selangau mill will introduce a 16MW biomass boiler to provide steam and electricity for the operation of the palm oil mill. The proposed CDM project will develop a CFB system with a steam generating capacity of 75 tonnes/hour. The CFB boiler combusts the pre-treated EFB, as described in previous section, combined with biogas that is recovered from anaerobic digestion of the POME. The inputs for the CFB boiler are EFB, fibre, shell and biogas.

The steam will be used to feed a turbine generator that will generate 15.82MW of electricity. 2.21MW of the electricity produced will be used in situ, for mill operation, while 13.6 MW will be sold to Sarawak Energy through a 21-year-long Power Purchase Agreement (PPA).

A.2.3.3 POME treatment

The POME contains organic materials and show high levels of COD. The discharge of effluents containing high levels of organic matter is prohibited in Sarawak. Traditionally, mills used open lagoons to breakdown the organic contents of the POME. The Sealangau mill is no exception, thus treats POME using open lagoons. The proposed CDM project will adopt more efficient treatment practice by introducing anaerobic digester tank. The biogas, containing high levels of methane, emitted by the POME during the anaerobic digestion process is captured and it is used as fuel for power and steam generation.

A.3. Project participants:

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Name of Party involved(*)	Project Participants	Kindly indicate if the Party involved wished to be considerers as project participants
Malaysia	Rimbunan Sawait Berhad	Yes
Japan	Sumitomo Heavy Industries Ltd.	No
Japan	Smart Energy Co., Ltd.	Yes
(*) in accordance with the CDM modalities and procedures, at the time of making the PDD (at the stage of validation), Parties involved may or may not have provided its approval. Approval by the Parties involved are required at the time of requesting for the registration.		

A.4. Technical description of the project activity:

A.4.1. Location of the project activity:

A.4.1.1. Host Party(ies):

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Malaysia

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

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Sarawak State

A.4.1.3. City/Town/Community etc:

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Selangau town

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

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The project is located at RH’s Selangau Mill, 5 kilometres from the Selangau Village in Central Sarawak State. The mill is situated alongside the major road number 3014 that connects Mukah, coastal industry city, and Selangau. The road is upgrading for the heavy construction and traffic due to development of the Mukah industry zone.

The vicinity of the Project locations are palm plantations, rice paddy and small vegetable farms owned by independent farmers.

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

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The project falls under UNFCCC's sectoral scope #1(Energy industries (renewable/non-renewable sources) and #13 (waste handling and disposal).

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

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A.4.3.1 EFB pre treatment process

Using EFB to produce heat and steam is not a new process for the Malaysian palm oil industry: EFB and other biomass waste are combusted in plant's boiler to generate steam and heat for internal use. However, EFB's suitability as a fuel has been questioned due to the formation of slag in the combustion chamber. This slag reduces significantly the efficiency of the boiler throughout time.

The proposed project will develop a pre-treatment process for EFB to improve fuel suitability. The process consists in washing EFB with chemicals and dehydrating them with a separator. Throughout this process, EFB moisture is reduced from about 65% to less than 50% while potassium content is reduced from 2.4% (average) to less than 0.3%. The calorific value of the processed EFB is then improved from 5000kcal/kg to 5700 kcal/kg.

A.4.3.2.CFB boiler for cogeneration

The project will employ a Circulating Fluidized Bed (CFB) boiler. Sumitomo Heavy Industries (SHI) is a Licensee of Foster Wheeler CFB boiler in Asia. The CFB boiler is very efficient with an expected energy conversion efficiency of 92%. It has an automatic combustion control system that ensures the effectiveness of biomass combustion and control of emission. Emission control is made using a multi-cyclone system and the emissions comply with the prevailing emission regulation standards in Malaysia. In fact, the system performs much better than the existing palm oil mill boilers which are manually operated. CFB has multiple advantages compared with conventional stoker-type boiler. These advantages are the following:

1) Ability to combust variety of fuels

One of the most recognized advantages of the CFB boiler technology lies in its ability to burn a wide variety of fuels. Today, there is ample experience demonstrating CFB boiler's ability to burn numerous low grade fuels such as peat, coal wastes, sludge, municipal wastes, biomass, oil shale, and petroleum coke, in addition to any high grade coals. CFB boiler can be designed to burn these fuels individually or in combination, providing the end user with flexibility in choosing the best economic mix to minimize generation costs. This is particularly attractive for palm-oil mills where sources of waste are varied and are combusted all together.

2) Inherent Low Emission Capability

CFB boiler is also widely recognized as being inherently low in emissions. This is in large part due to the low combustion temperatures, which reduces thermal NOx formation, and the ability to introduce limestone directly into the furnace to control SO_2 emissions. Because combustion efficiency is high, a combustion temperature of 850-900ºC will suffice, which is much lower than other systems. This enables NOx generation to be curbed.

3) Reliable Technology

CFB boiler technology has now matured to the point that operating plants have demonstrated its reliableness comparable to, or exceeding, the most modern solid fuel fired plants. The high reliability of CFB boiler is also widely recognized within the financial community and numerous plants have been financed through non-recourse financing. Almost all of the active international project finance banks have provided non-recourse financing for projects using CFB boiler technology. Within the past several years, the credit rating agencies have included projects using CFB boiler technology among those which qualify for an investment grade rating.

Potential fuel character is summarized as follows;

Fuel	Amount	LHV
EFB(post-treatment)	9.6 t/h	5,700kcal/kg
Fibre	5.0 t/h	3,200kcal/kg
Shell	2.29 t/h	4,500kcal/kg
Bio gas from lagoon	1,903 Nm3/h	5,130kcal/Nm3

A.4.3.3 POME treatment Process

Palm oil mill effluent, known as POME, contains rich organic materials. POME has been treated in the backyard of the palm oil mill through open lagoons and sometimes aerated processing pond. Throughout the anaerobic process, methane gas is released into the atmosphere and contributes towards global warming. Moreover, the odor of the POME is a nuisance for the mill workers and for the vicinity. The proposed projects process POME via anaerobic digestion and collect biogas, which then will go through de-moisturizer and sent to CFB boiler for an additional fuel for steam generation. The 95% of the biogas will be utilized and rest are flared to minimize POME’s contribution towards global warming.

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

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Years	Annual estimation of emission reductions in tonnes of CO2e
2011	93,934
2012	130,860
2013	162,601
2014	174,605
2015	184,731
2016	193,275
2017	200,483
2018	206,564
2019	211,694
2020	216,023
Total estimated reductions (tonnes of CO2e)	**1,774,770**
Total number of crediting years	**10**
Annual average over the crediting period of estimated reductions (tonnes of CO2e)	**177,477**

A.4.5. Public funding of the project activity:

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Part of feasibility study of the project is funded by Global Environmental Center (GEC), an incorporated agency under Japanese Ministry of Environment. The funding is not counted as a part of Japanese official development aid programme.

SECTION B. Application of a baseline and monitoring methodology

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

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The proposed project employs two approved baseline and monitoring methodologies for claiming emission reductions.

ACM0006 Ver. 06.2: "Consolidated methodology electricity generation from biomass residues"
Also, applying ACM0006 implies an application of ACM0002"Consolidated baseline methodology for grid-connected electricity generation from renewable sources".
Its tools are as follows:
"Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site";
"Tool to calculate project or leakage CO2 emissions from fossil fuel combustion";
"Tool to calculate baseline, project and/or leakage emissions from electricity consumption";
"Combined too to identify the baseline scenario and demonstrate additionality".

The project also employs following methodology:
ACM0014 Ver. 02.1: "mitigation of greenhouse gas emissions from treatment of industrial wastewater".

The project involves three emission reduction measures. One is to alternate grid electricity to internally generated electricity from recovered biomass. The other is to avoid methane emission from decay of EFB and finally, avoidance of methane gas emissions from the POME treatment in the open lagoons. ACM0006 is applied for emission reductions through alternation of grid electricity and avoidance of methane emissions from the EFB. ACM0014 is applied for avoidance of methane emissions from the POME.

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

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Proposed project is a biomass cogeneration power plant that generates electricity and thermal energy from renewable energy sources.

Paragraph 48 of "the Modalities and procedures of the Clean Development Mechanisms" states as follows;

"48. In choosing a baseline methodology for a project activity, project participants shall select from among the following approaches the one deemed most appropriate for the project activity, taking into account any guidance by the executive board, and justify the appropriateness of their choice:
(a) Existing actual or historical emissions, as applicable; or
(b) Emissions from a technology that represents an economically attractive course of action, taking into account barriers to investment; or
(c) The average emissions of similar project activities undertaken in the previous five years, in similar social, economic, environmental and technological circumstances, and whose performance is among the top 20 per cent of their category."

Since the project activity will serve to reduce emissions from existing emission sources and that biomass, particularly EFB(Empty Fruit Bunch) is not a commonly used fuel for power generation, the project meets the choice a) for baseline scenario.

B.2.1 Application of ACM0006
According to the selected baseline methodology, ACM0006 applicability conditions are addressed hereunder and the project comply with condition as follows;

ACM0006 set following applicability conditions and project satisfies these conditions as follows;

- *No other biomass types than biomass residues are used in the project plant and these biomass residues are used in the project and these biomass residues are the predominant fuel used in the project plant (Some fossil fuel may be co-fired).*
  The project intends to rely on palm oil process residues.

- *For projects that use biomass residues from the production process, the implementation of the project shall not result in an increase of the processing capacity of raw input or in other substantial changes in this process.*
  The Selangau mill has its own expansion plan, as per its board of directors' decisions. The proposed project does not result in increase of the processing capacity because of CDM project implementation or substantial changes of its processes.

- *The biomass residues used by the project facility should not be stored for more than one year.*
  The intended palm oil mill's waste are stored at the EFB handling yard and the shell handling yard respectively. These materials will be delivered with conveyer belt to the newly installed boiler and the retention time of these fuels are no more than a month accordingly to the mechanical designing of the system.

- *No significant energy quantities, except from transportation or mechanical treatment of the biomass residues, are required to prepare the biomass residues for fuel combustion, i.e. projects that process the biomass residues prior to combustion.*
  Fuels for biomass boilers are not externally delivered.

Therefore, the project satisfied an applicability condition of the ACM0006 for baseline methodology.

B.2.2 Application of ACM0014
While the project also employs ACM0014 Ver. 02.1 for methane capturing from palm oil mill effluent (POME). The methodology is designed for the project that intends to reduce methane emissions from industrial wastewater treatment. The proposed project intends to replace the open lagoons with an anaerobic digester tank to capture the methane generated during the anaerobic processing of the POME. Therefore ACM0014 is applicable.

According to ACM0014, the proposed project meets scenario described in Table 1"Scenarios applicable to the methodology". The baseline of the project activity is "The wastewater is not treated, but directed to open lagoons that have clearly anaerobic conditions". The envisaged project activity correspond to this baseline is" The wastewater is treated in a new anaerobic digester. The biogas extracted from the anaerobic digester is flared and / or used to generate electricity and / or heat. The residual from the anaerobic digester after treatment is directed to open lagoons or is treated under clearly aerobic conditions (e.g. dewatering and land application)". The project activity will capture methane gas for the POME and sludge are collected. The sludge will be treated in aerobic conditions. Thus the proposed project activity will satisfy an application condition of the ACM0014.

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

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Project boundary of the project is set as follows.

Emission sources included in or excluded from the project boundary is as follows.

ACM0006

	Source	**Gas**		**Justification/Explanation**
Baseline	Electricity generation	CO_2	Included	Main emission source
		CH_4	Excluded	Excluded for simplification. This is conservative.
		N_2O	Excluded	Excluded for simplification. This is conservative.
	Heat generation	CO_2	Included	Main emission source
		CH_4	Excluded	Excluded for simplification. This is conservative.
		N_2O	Excluded	Excluded for simplification. This is conservative.
	Uncontrolled burning or decay of surplus biomass residues	CO_2	Excluded	It is assumed that CO_2 emissions from surplus biomass residues do not lead to changes of carbon pools in the LULUCF sector.
		CH_4	Included	This is included for surplus biomass since the baseline scenario was determined as B2 for EFB. Uncontrolled burning is also included in case of such activity happen during the crediting period.
		N_2O	Excluded	Excluded for simplification. This is conservative.
Project Activity	On-site fossil fuel consumption due to the project activity (stationary and mobile)	CO_2	Included	Included in case of such activity
		CH_4	Excluded	Excluded for simplification. This emission source is assumed to be very small.
		N_2O	Excluded	Excluded for simplification. This emission source is assumed to be very small.
	Off-site transportation of biomass residues	CO_2	Included	Included in case of such activity
		CH_4	Excluded	Excluded for simplification. This emission source is assumed to be very small.
		N_2O	Excluded	Excluded for simplification. This emission source is assumed to be very small.
	Combustion of biomass residues for electricity generation and heat generation	CO_2	Excluded	It is assumed that CO_2 emissions from surplus biomass residues do not lead to changes of carbon pools in the LULUCF sector.
		CH_4	Included	Consistent with inclusion of CH_4 emissions from uncontrolled burning and decay of

				biomass residues in the baseline.
		N_2O	Excluded	Excluded for simplification. This emission source is assumed to be very small.
	Storage of biomass residues	CO_2	Excluded	It is assumed that CO_2 emissions from surplus biomass residues do not lead to changes of carbon pools in the LULUCF sector.
		CH_4	Excluded	Excluded for simplification. This emission source is assumed to be very small.
		N_2O	Excluded	Excluded for simplification. This emission source is assumed to be very small.
	Wastewater from the treatment of biomass residues	CO_2	Excluded	It is assumed that CO_2 emissions from surplus biomass residues do not lead to changes of carbon pools in the LULUCF sector.
		CH_4	Excluded	The wastewater is treated in an aerobic digester.
		N_2O	Excluded	Excluded for simplification. This emission source is assumed to be small.

ACM0014

	Source	**Gas**		**Justification/Explanation**
Baseline	Wastewater treatment process	CH_4	Included	The major source if emissions in the baseline from open lagoons.
		N_2O	Excluded	Excluded for simplification. This is conservative.
		CO_2	Excluded	CO_2 emissions from the decomposition of organic waste are not accounted for
	Electricity consumption/ generation	CO_2	Included	No electricity is consumed for the operation of the wastewater treatment system. Displacement of the generation of electricity in grid is accounted by the methodology ACM0006. Therefore CO_2 from the electricity consumption/generation is excluded from the project boundary.
		CH_4	Excluded	Excluded for simplification. This is conservative.
		N_2O	Excluded	Excluded for simplification. This is conservative.
	Thermal energy generation	CO_2	Excluded	Biomass residue is used for the baseline scenario, therefore the baseline CO_2 emissions from thermal energy generation is excluded.
		CH_4	Excluded	Excluded for simplification. This is conservative.
		N_2O	Excluded	Excluded for simplification. This is conservative.

Project Activity	Wastewater treatment process	CH_4	Included	The treatment of wastewater under the project activity includes the following emissions: (i) Methane emissions from the lagoons (ii) Physical leakage of methane from the digester system (iii) Methane emissions from flaring (iv) Methane emissions from land application of sludge (in case of such activity)
		CO_2	Excluded	CO_2 emissions from the decomposition of organic waste are not accounted for
		N_2O	Included	In the case of such activity happens during the crediting period.
	On-site electricity Use	CO_2	Included	If electricity is generated with biogas from an anaerobic digester, these emissions are not accounted for. Any on-site electricity consumption should be subtracted from the electricity generation of the digester.
		CH_4	Excluded	Excluded for simplification. This emissions source is assumed to be very small.
		N_2O	Excluded	Excluded for simplification. This emissions source is assumed to be very small.
	On-site fuel consumption	CO_2	Included	Included in case of such activity happens
		CH_4	Excluded	Excluded for simplification. This emissions source is assumed to be very small.
		N_2O	Excluded	Excluded for simplification. This emissions source is assumed to be very small.

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

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B.4.1 identification of the baseline scenario

Identification of the baseline scenario for ACM0006

To determine the most plausible scenario in an application of ACM0006, steps are outlined as follows.
Step 1 Identification of alternative scenarios
Step 2 Barrier analysis
Step 3 Investment analysis
Step 4 Common practice analysis

Biomass residues to be considered in this project are:

k_1: Fibre
k_2: Shell
k_3: EFB (Empty Fruit Bunch)

Each biomass residue would be considered for different scenario as required by the methodology ACM0014.

According to the ACM0006, the selection of the most plausible scenario is selected in line with “Combined tool to identify the baseline scenario and demonstrate additionality”. The tool requires determining the followings:

- How power would be generated in the absence of the CDM project activity;
- What would happen to the biomass residues in the absence of the project activity;
- In case of cogeneration projects, how the heat would be generated in the absence of the project activity.

Step 1 of ACM0006: Identification of the alternative scenarios

For power generation, the realistic and credible alternatives may include, inter alia:

P1: The proposed project activity not undertaken as a CDM project activity.
P2: The continuation of power generation in an existing biomass residue fired power plant at the project site, in the same configuration, without retrofitting and fired with the same type of biomass residues as (co-)fired in the project activity.
P3: The generation of power in an existing captive power plant, using only fossil fuels.
P4: The generation of power in the grid.
P5: The installation of a new biomass residue fired power plant, fired with the same type and with the same annual amount of biomass residues as the project activity, but with a lower efficiency of electricity generation (e.g. an efficiency that is common practice in the relevant industry sector) than the project plant and therefore with a lower power output than in the project case.
P6: The installation of a new biomass residue fired power plant that is fired with the same type but with a higher annual amount of biomass residues as the project activity and that has a lower efficiency of electricity generation (e.g. an efficiency that is common practice in the relevant industry sector) than the project activity. Therefore, the power output is the same as in the project case.
P7: The retrofitting of an existing biomass residue fired power, fired with the same type and with the same annual amount of biomass residues as the project activity, but with a lower efficiency of electricity generation (e.g. an efficiency that is common practice in the relevant industry sector) than the project plant and therefore with a lower power output than in the project case.
P8: The retrofitting of an existing biomass residue fired power that is fired with the same type but with a higher annual amount of biomass residues as the project activity and that has a lower efficiency of electricity generation (e.g. an efficiency that is common practice in the relevant industry sector) than the project activity.
P9: The installation of a new fossil fuel fired captive power plant at the project site.

Exclusion of P2 (for $k_{1,2and3}$): The proposed project activity would use EFB, shell and fibre as a source of biomass fuel where as the present biomass residue fired power plant use only shell and fibre as a source of biomass fuel. The present existing biomass residue fired power plant cannot fire same type of biomass residue as (co-)fired in the project activity and thus P2 could be excluded from the realistic and credible alternatives.

Exclusion of P3 (for $k_{1,2and3}$): The present captive power plant use biomass waste (shell and fibre) as a main source of fuel and it is not realistic to introduce fossil fuel as a main source of power as it would significantly increase the energy cost. This would also increase the baseline emissions, thus lack the conservativeness approach. Therefore, P3 could be excluded from the realistic and credible alternatives.

Exclusion of P6 and P8 (for $k_{1,2and3}$): The project activity is planned to make the full use of the biomass residues generated from the palm oil mill. It would not be possible to use higher annual amount of biomass residues as the project activity, therefore P6 and P8 could be excluded from the realistic and credible alternatives.

Exclusion of P7 (for $k_{1,2and3}$): Current capacity of the cogeneration plant is 1.6MW, but it is expected for the power demand of the mill in the future (during the period of project activity) to be over 3.5MW. This is beyond retrofitting as the power plant requires significantly higher level of power output. Therefore, P7 could be excluded from the realistic and credible alternatives.

Exclusion of P9 (for $k_{1,2and3}$): The installation of a new fossil fuel fired captive power plant would increase the fuel cost, thus it is economically unattractive and it would also increase the baseline emissions, thus lack the conservativeness approach. Therefore, P9 could be excluded from the realistic and credible alternatives.

Therefore, the plausible power generation baseline scenarios for further evaluation are scenarios P1, P4 and P5.

If the proposed project activity is the cogeneration of power and heat, project participants shall define the most plausible baseline scenario for the generation of heat. For heat generation, realistic and credible alternative(s) may include, inter alia:

H1: The proposed project activity not undertaken as a CDM project activity
H2: The proposed project activity (installation of a cogeneration power plant), fired with the same type of biomass residues but with a different efficiency of heat generation (e.g. an efficiency that is common practice in the relevant industry sector)
H3: The generation of heat in an existing captive cogeneration plant, using only fossil fuels
H4: The generation of heat in boilers using the same type of biomass residues
H5: The continuation of heat generation in an existing biomass residue fired cogeneration plant at the project site, in the same configuration, without retrofitting and fired with the same type of biomass residues as in the project activity
H6: The generation of heat in boilers using fossil fuels
H7: The use of heat from external sources, such as district heat
H8: Other heat generation technologies (e.g. heat pumps or solar energy)

Exclusion of H3 (for $k_{1,2and3}$): The existing captive cogeneration plant is designed to use biomass residues as source of fuel and not fossil fuel, and also the use of fossil fuel would increase the baseline emissions, which is against the conservativeness approach. Therefore H3 could be excluded from the realistic and credible alternatives.

Exclusion of H5 (for $k_{1,2and3}$): The proposed project activity would use EFB, shell and fibre as a source of biomass fuel where as the present biomass residue fired power plant only use shell and fibre as a source of biomass fuel. The present existing biomass residue fired cogeneration plant cannot fire same type of biomass residue as fired in the project activity and thus H5 could be excluded from the realistic and credible alternatives.

Exclusion of H6 (for $k_{1,2and3}$): The existing captive cogeneration plant is designed to use biomass residues as source of fuel and not fossil fuel. It would be costly to replace the existing biomass boiler with a fossil fuel fired boiler and also the use of fossil fuel would increase the baseline emissions, which is against the conservativeness approach. Therefore H6 could be excluded from the realistic and credible alternatives.

Exclusion of H7 (for $k_{1,2and3}$): There is no infrastructure in Sarawak such as district heat, including the project site. The palm oil mill is located in a remote area, thus it is unrealistic to use heat from external sources, and thus H6 could be excluded from the realistic and credible alternatives.

Exclusion of H8 (for $k_{1,2and3}$): Solar and heat pump technologies would not provide enough heat and pressure required by the project, and it would also be too costly, thus H8 could be excluded from realistic and credible alternatives.

Therefore plausible heat generation alternative scenario for further consideration are H1 H2 and H4.

For the use of biomass residues, the realistic and credible alternative(s) may include, inter alia:

B1: The biomass residues are dumped or left to decay under mainly aerobic conditions. This applies, for example, to dumping and decay of biomass residues on fields.

B2: The biomass residues are dumped or left to decay under clearly anaerobic conditions. This applies, for example, to deep landfills with more than 5 meters. This does not apply to biomass residues that are stock-piled or left to decay on fields.

B3: The biomass residues are burnt in an uncontrolled manner without utilizing it for energy purposes.

B4: The biomass residues are used for heat and/or electricity generation at the project site

B5: The biomass residues are used for power generation, including cogeneration, in other existing or new grid-connected power plants

B6: The biomass residues are used for heat generation in other existing or new boilers at other sites

B7: The biomass residues are used for other energy purposes, such as the generation of biofuels

B8: The biomass residues are used for non-energy purposes, e.g. as fertilizer or as feedstock in processes (e.g. in the pulp and paper industry)

The disposal of the biomass differs, according to different biomass residues, thus baseline scenario for the use of biomass residues are identified separately as required by the PDD document.

k_1 and k_2 – Shell and fibre

Exclusion of B1,B2 and B3 (for k_1 and k_2): Fibre and shell are widely used as a source of fuel for palm oil mills. Energy demand for the palm oil mill could be met by utilising these biomass residues. Thus, the biomass residues are not dumped or burned in the fields, therefore B1, B2 and B3 could be excluded from the realistic and credible alternatives.

Exclusion of B5 and B6 (for k_1 and k_2): Fibre and shell are not used for power generation, including cogeneration, in other existing or new grid-connected power plants, nor they are used in other new or existing boilers for heat generation purposes therefore B5 and B6 could be excluded from the realistic and credible alternatives.

Exclusion of B7 and B8 (for k_1 and k_2): Biomass residues are not used to generate biofuels, fertilisers, or feedstock in processes, therefore B7 and B8 could be excluded from the realistic and credible alternatives.

Therefore B4 remain as the only plausible realistic and credible alternative for the use of biomass residue scenario for fibre and shell.

k_3 – EFB

Exclusion of B1 (for k_3): EFB are utilised for mulching purposes, but this is not a long term biomass residue management. The EFB mulch could absorb water, but once the palm oil grows, its own fallen dry leaves could function as mulch. It is much more economically viable for the dry leaves to act a mulch rather than EFB, since this will not require transportation of biomass residues from one place to another. Therefore, B1 could be excluded from realistic and credible alternatives.

Exclusion of B3 (for k_3): Any biomass residues are not to be burned in an uncontrolled manner by Malaysian law, therefore B3 could be excluded from the realistic and credible alternatives.

Exclusion of B4, B5 and B6 (for k_3): Due to its higher moisture content and low melting point, it is difficult to combust EFB using conventional boilers. Some high technology boilers and EFB treatment system were developed, including the project activity, to combust EFB, but these are still uncommon, therefore B4, B5 and B6 could be excluded from realistic and credible alternatives. However, if the alternative scenario is the project activity not undertaken as CDM, then B4 could be applicable as a realistic and credible alternative as described in “Combination of scenarios” below.

Exclusion of B7 (for k_3):
Currently there is no commercially available technology to utilise EFB as biofuel or other alternative energy purposes, therefore B7 could be excluded from realistic and credible alternatives.

Exclusion of B8 (for k_3):
EFB has been used as a fertiliser, but it is still at the development stage and costly, thus these are registered as CDM projects. Also, fertilisers are produced only in small scale mills and never in large quantities. The project site would process 120tonnes that would be beyond the capacity of any fertiliser producing facilities, thus B8 could be excluded from realistic and credible alternative scenarios.

The only remaining realistic and credible alternative scenario for the disposal of EFB would be B2 that is the biomass residues are dumped or left to decay under clearly anaerobic conditions. (However, for the alternative scenario of project activity not undertaken as CDM, B4 applies)

Combination of scenarios
Before proceeding to step 2 of the ACM0006, all the credible combinations of the baseline are identified as follows:

Alternative combined scenario I: (P1, H1, B4)
This combined alternative scenario describes the project activity not undertaken as CDM, which is installation of a biomass power plant with EFB treatment and cogeneration and the biomass including fibre, shell and EFB are burnt for heat and electricity generation.

Alternative combined scenario II: (P4, P5, H2, H4, B2, B4)
This is the combined scenario in which new, but conventional biomass power plant fired by fibre and shell are built and operated to supply electricity to the mill. The electricity that would have been generated by the project activity to the grid would be supplied by the existing power plants. Heat is

generated by the boiler for cogeneration purpose. Shell and fibre are utilised for heat and electricity generation, but EFB is dumped in a landfill site under clearly anaerobic condition.

Step2 for ACM0006: Barrier analysis

Step 2a: Identify barriers that would prevent the implementation of alternative scenario

- Investment barriers, other than insufficient financial returns as analysed in Step3
- Technological barriers
- Lack of prevailing practice

Step2b: Eliminate alternative scenarios which are prevented by the identified barriers

Exclusion of alternative combined scenario I:

Investment barriers, other than insufficient financial returns as analysed in Step3

All of the EFB combustion power plant built in Sarawak has applied as CDM. In Malaysia there is no EFB combustion power plant that is funded privately without the assistance of public grant/finance and/or CDM finance. This relates with technological barrier, since private sector is not confident enough from the past results of various EFB technologies to invest in EFB combustion power plant technologies.

Technological barrier

The proposed activity requires the construction, operation and maintenance of the CFB boiler, which is a sophisticated boiler, not available in Sarawak, and also the construction, operation, maintenance of the EFB treatment system requires specialist skills. CFB has long been used in Japan and the EFB treatment has been tested out by Sumitomo Heavy industries in Japan, but skills for construction, operation and maintenance of EFB boiler and EFB treatment system is not available in Sarawak. Sumitomo Heavy Industries is planning to provide capacity development and technology transfer to the local engineers during the implementation of the project activity. It is expected that Sumitomo Heavy Industries is sending their engineers on site at least for the first year, before the local engineers would be able to operate and maintain the biomass power plant by themselves.

Lack of prevailing practice

The biomass power plant using a CFB boiler is first of its kind in Sarawak. And the EFB treatment system for this project activity is also first of its kind in Sarawak. The EFB combustion power plant CDM project in Sarawak uses stoker boiler technology, which is significantly different from the mechanism of a CFB boiler. The use of CFB boiler for combustion of EFB is first of its kind.

How CDM would alleviate the identified barriers

Although the CFB boiler technology for EFB combustion and EFB pre-treatment technology has been tested out in Japan, there is a perceived risk of EFB combustion technology. Various EFB combustion pilot project has been carried out in Malaysia using government subsidies, but yet there is no conclusive evidence that it is viable commercially in the long-run. CDM could account for such risk-premium through financial improvement the project activity. There is a lack of expertise in Sarawak to implement the project activity, and this is also a risk factor for the project developer. However Malaysian DNA requires the Annex I nation to provide technology transfer as part of the criteria for the approval of the CDM. This would guarantee the project developer that Sumitomo is to provide technology transfer to the Sarawak State, thus making the project sustainable in the long run. Also, with the extra financial gains from the CDM, Sumitomo Heavy Industries would be able to incur the cost of capacity development and technology transfer to the project finance, thus making the project feasible for the local project developer and the Japanese technology provider, therefore the CDM would alleviate the identified barriers and enable the project to become feasible.

Non-Exclusion of the alternative combined scenario II:

Investment barriers, other than insufficient financial returns as analysed in Step3

There are no investment barriers as captive biomass cogeneration plants are normally self-financed by the palm oil mills themselves.

Technological barrier

There are no technological barriers as combustion of fibre and shell is standard practice in Malaysia including Sarawak. For example, the Selangau palm oil mill constructed the biomass cogeneration power plant when they built the palm oil mill itself. There are local engineers available to construct, operate and maintain the biomass cogeneration power plant for the combustion of fibre and shell. There is already grid connectivity available in Sarawak.

Lack of prevailing practice

As mentioned above, the combustion of Fibre and shell is a standard practice for the palm oil mill and supply of electricity from the grid could be achieved in most of the major cities and industrial areas in Sarawak.

Therefore alternative combined scenario II is the only remaining alternative scenario, thus would qualify as the baseline scenario. This scenario falls under the description of Scenario 16 presented in the table2 of the “Approved consolidated baseline and monitoring methodology ACM0006”. Therefore scenario 16 shall be used to determine the emissions reduction proceeding from section B.6. for the methodology ACM0006.

Identification of the alternative scenarios for ACM0014

To determine most plausible scenario in an application of ACM0014, steps are outlines as follows.
Step 1Identification of alternative scenarios
Step 2 Eliminate alternatives that are not complying with applicable laws and regulations
Step 3 Eliminate alternatives that face prohibitive barriers
Step 4 Compare economic attractiveness of remaining alternatives

Step1for ACM0014: Identification of alternative scenarios

Plausible alternative scenarios for the treatment of wastewater (W) are

W1. The use of open lagoons
W2. Direct release of wastewaters to a nearby water body;
W3. Aerobic wastewater treatment facilities (e.g., activated sludge or filter bed type treatment);
W4. Anaerobic digester with methane recovery and flaring;
W5. Anaerobic digester with methane recovery and utilization for electricity or heat generation.

Plausible alternative scenarios for the generation of electricity are

E1. Power generation using fossil fuels in a captive power plant;
E2. Electricity generation in the grid;
E3. Electricity generation using renewable sources.

Plausible alternative scenarios for the generation of heat are

H1. Co-generation of heat using fossil fuels in a captive cogeneration power plant;
H2. Heat generation using fossil fuels in a boiler;
H3. Heat generation using renewable sources.

Step2 forACM0014: Eliminate alternatives that are not complying with applicable laws and regulations

W2 is prohibited under the Environment Quality Act (1974) Environment Quality (Sewage and Industrial Effluents) Regulations (1979). Therefore scenario W2 is excluded from the alternative scenarios.

Step3 for ACM0014: Eliminate alternatives that face prohibitive barriers

The scenarios that face prohibitive barriers were identified using the “Tool for the demonstration and assessment of additionality”.

Sub-step3a: Identify barriers that would prevent the implementation of the proposed CDM project activity:

Following were identified as realistic and credible barriers that would prevent the implementation of the proposed project activity from being carried out if the project activity was not registered as a CDM activity.

(a) Investment barrier
(b) Technological barriers
(c) Barriers due to prevailing practice

Sub-step3b: Show that the identified barriers would not prevent the implementation at least one of the alternatives:

Alternative scenarios for the treatment of wastewater

W1: Waste management of the open lagoon is one of the most simple and effective ways to treat POME. Open lagoon has been the main method to treat POME in Malaysia and elsewhere in Southeast Asia. The method requires low capital cost and the treatment system does not require any energy input if each lagoon is placed from higher ground to lower ground as this is the case for the lagoon in Selangau Mill. Therefore, no investment barrier is identified.

W3: The treatment of POME using open lagoons do not require any energy, where as aerobic treatment of the POME would require large quantities of energy to operate the pump and to supply the oxygen to the wastewater. The aerobic wastewater facility would require high initial investment with no expected return such as from fuel savings. Due to these circumstances, most of the palm oil facilities do not use aerobic wastewater treatment system to treat POME. Therefore, this alternative scenario faces investment as well as barriers due to prevailing practices.

W4: Similar to W3, anaerobic digester technology poses significant initial investment cost, yet there is no expected return such as from fuel saving. The technology does exist in Malaysia, but is not of common use by the palm oil mills. Therefore, this alternative scenario faces investment and barriers due to prevailing practices.

W5: Anaerobic system with methane recovery and utilisation require much higher initial investment in comparison with the conventional open lagoon system. The system is complex and biogas generation depends on many factors such as reactor temperature, pH, COD, which will affect bacterial activities hence the rate at which methane is being produced. The utilisation of the biogas would provide return through such as fuel cost saving, but this will not be enough to justify the high investment and the risk associated with it, due to the fact that very little biogas project has been conducted in Malaysia and even less in the Sarawak State. Therefore, this alternative scenario faces investment and technological barriers as well as barriers due to prevailing practices.

Therefore, W1 is considered as the only realistic and credible alternative scenario for treatment of water.

Alternative scenarios for electricity generation

E1: The power generation of fossil fuel in a captive power plant is capital intensive and its operational cost is high. Conventional palm oil mill would have a captive power plant that is run by biomass residues such as fibre and shell, and possess a small fossil fuel powered generator only as a back up to generate electricity when the plant is not operating. This scenario faces investment barrier as well as barriers due to prevailing practices. Also, the use of fossil fuel would increase the baseline emissions, thus lack the conservativeness approach, therefore it could not be considered as a credible alternative scenario.

E2: Grid connected electricity is available across Sarawak and the electricity cost is subsidised by the government and major industries and residential areas of Sarawak is supplied by the grid electricity. The excess electricity that is supplied by the project activity to the grid could be easily be replaced by the present grid connectivity and the electricity provided by the Sarawak Energy Berhad. Therefore there are no prevailing barriers for this alternative scenario.

E3: Significant amount of biomass residue are generated from the palm oil mill, but these are fully utilized by the biomass power plant part of the project activity and this includes the use of EFB. There is no biomass residue left to generate electricity which would have been generated in the absence of the methane gas collection and combustion part (ACM0014 part) of the project activity. Also there is no other commercially available renewable energy technology within the vicinity of the project activity other than those that are realised only through the presence of the CDM scheme, which the technology is imported from outside of Sarawak. Therefore this scenario faces investment, technology barriers and barriers due to prevailing practices.

Therefore, E2 is considered as the only realistic and credible alternative power generation scenario.

Alternative scenarios for heat generation

H1, H2: Cogeneration of heat using fossil fuels in a captive cogeneration power plant and/or boiler is capital intensive and operational cost is high. Conventional palm oil mill would have a captive cogeneration power plant that is fuelled by biomass residues such as fibre and shell and thus heat is not generated from the fossil fuel power. These scenarios face investment barrier as well as barriers due to prevailing practices. Also, the use of fossil fuel would increase the baseline emissions, thus lack the conservativeness approach, thus it could not be considered as a credible alternative scenario.

H3: Biomass residues such as fibre and shell, generated from the palm oil mill, are used for the heat generation, required by the palm oil mill. The biomass power generation part of the project activity would produce excess heat and electricity. The electricity would be sold to the grid, but the heat generated from cogeneration could only be utilized by the palm oil mill. This implies that in the absence of the project activity, biomass would be used to generate heat, for the palm oil mill, instead of biogas. Therefore, alternative scenario H3 does not face any prevailing barriers.

Therefore only H3 is the realistic and credible alternative scenario for heat generation.

Step4 for ACM0014: Compare economic attractiveness of remaining alternatives

Only one scenario is identified for each of the alternative (treatment of waste water, generation of electricity, and generation of heat), thus step 4 shall not be carried out.

Therefore W1, E2, and H3 are used as the baseline scenario for ACM0014.

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

Assessment and additionality for methodologies ACM0006 and ACM0014 has been demonstrated in Section 5.4.

B.6. Emission reductions:

B.6.1. Explanation of methodological choices:

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The project employs two methodologies to enhance sources of emission sources. ACM0006 and ACM 0014. Scenario 16 is used for the emission reduction calculation of ACM 0006 as it was determined in B.4.

The emission reduction calculations are as follows:

<u>ACM0006 Emission reduction calculation</u>

Emission Reductions

$$ER_y = ER_{electricity,y} + BE_{biomass} - PE_y - L_y$$

where:

ER_y = Emission reductions of the project activity during the year *y* (tCO_2/yr)

$ER_{electricity,y}$ = Emission reductions due to displacement of electricity during the year *y* (tCO_2/yr)

$BE_{biomass}$ = Baseline emissions due to natural decay or burning of anthropogenic sources of biomass residues during the year *y* (tCO_2/yr)

PE_y = Project emissions during the year *y* (tCO_2/yr)

L_y = Leakage emissions during the year *y* (tCO_2/yr)

Project Emissions

The waste water system from the power generation plant is designed to flow into the biogas digester system where methane gas is captured for combustion and any remaining biogas is flared. Thus, emissions from the anaerobic breakdown of biomass in waste water are excluded from the calculation.

Project emissions are calculated as follows:

$$PE_y = PET_y + PEFF_y + PE_{EC,y} + \left(GWP_{CH4} \times PE_{Biomass,CH4,y}\right)$$

where:

PET_y = CO_2 emissions during the year *y* due to transportation of the biomass residues to the project plant (tCO_2/yr)

$PEFF_y$ = CO_2 emissions during the year *y* due to fossil fuels co-fired by the generation facility or other fossil fuel consumption at the project site that is attributable to the project activity (tCO_2/yr)

GWP_{CH4} = Global Warming Potential for methane valid for the relevant commitment period

$PE_{Biomass,CH4,y}$ = CH_4 emissions from the combustion of biomass residues during the year *y* (tCH_4/yr)

$PE_{EC,y}$ = CO_2 emissions from on-site consumption of electricity

Carbon dioxide emissions from combustion of fossil fuels for transportation of biomass residues to the project plant (PET_y)

This project does not expect to transport fibre, shell, or EFB to the project site using vehicles, since only the biomass residues from the Selangau mill is expected to be utilised. However, if biomass residue is transported in to the project site, then it would be monitored and the project emission would be calculated using the following equation:

Option 1:
Emissions are calculated on the basis of distance and the number of trips (or the average truck load)

$$\mathrm{PET_y} = \frac{\sum_k \mathrm{BF_{T,k,y}}}{\mathrm{TL_y}} \times \mathrm{AVD_y} \times \mathrm{EF_{km,CO2,y}}$$

where:

$\mathrm{BF_{T,k,y}}$ = Quantity of biomass residue type *k* that has been transported to the project site during the year *y* (tonnes)

$\mathrm{TL_y}$ = Average truck load of the trucks used (tonnes) during the year *y*

$\mathrm{AVD_y}$ = Average round trip distance (from and to) between the biomass residue fuel supply sites and the site of the project plant during the year *y* (km)

$\mathrm{EF_{km,CO2,y}}$ = Average CO_2 emission factor for the trucks measured during the year y (tCO_2/km)

Carbon dioxide emissions from on-site consumption of fossil fuels ($PEFF_y$)

The project is expected to not to use any fossil fuel for its operation, however in case of any necessary use of fossil fuel such as for contingency measure, then the use of fossil fuel would be monitored and its emissions are calculated using the latest version of the "tool to calculate project or leakage CO_2 emissions from fossil fuel combustion":

$$\mathrm{PEFF_y} = \sum_i \mathrm{FC_{i,y}} \times \mathrm{COEF_{i,y}}$$

where:

$\mathrm{FC_{i,y}}$ = Quantity of fossil fuel type *i* combusted in the boiler during the year *y* (m^3/yr)

$\mathrm{COEF_{i,y}}$ = CO_2 emission coefficient of fuel type *i* in year *y* (tCO_2/m^3)

i = Fuel types combusted in the boiler during the year *y*

The CO_2 emission coefficient $COEF_{i,y}$ will be calculated according to the preferred option in the tool, option A, based on the chemical composition of fossil fuel type *i*, using the following approach:

$$COEF_{i,y} = w_{C,i,y,i} \times \rho_{i,y} \times 44/12$$

where:

$w_{C,i,y,i}$ = Weighted average mass fraction of carbon in fuel type *i* in year *y* (tC/tfuel)

$\rho_{i,y}$ = Weighted average density of fuel type *i* in year *y* (t/m^3)

44/12 = Fuel types combusted in the boiler during the year *y*

CO_2 emissions from electricity consumption ($PE_{EC,y}$)

The EFBs would be pre-treated before being inserted to the boiler to achieve higher and reliable combustion efficiency. The pre-treatment process of the EFB would use electricity, however all the electricity for this operation is planned to be supplied by the project power plant, thus emissions from this source is assumed to be zero. If any electricity is imported from the grid, it would be monitored and the emission would be calculated using the scenario A of “tool to estimate the baseline, project and /or leakage emissions from electricity consumption”:

$$\mathrm{PE}_{\mathrm{EC,y}} = \sum_{\mathrm{j}} \mathrm{EC}_{\mathrm{PJ,j,y}} \times \mathrm{EF}_{\mathrm{EL,j,y}} \times \left(1 + \mathrm{TDL}_{\mathrm{j,y}}\right)$$

where:

$PE_{EC,y}$ = Project emissions from electricity consumption in year *y* (tCO_2/yr)

$EC_{PJ,j,y}$ = Quantity of electricity consumed by the project electricity consumption source *j* in year *y* (MWh/yr)

$EF_{EL,j,y}$ = Emission factor for electricity generation for source *j* in year *y* (tCO_2/MWh) (Option A1 in Scenario A is chosen)

$TDL_{j,y}$ = Average technical transmission losses for providing electricity to source *j* in year *y*

Methane emission from electricity combustion of biomass residues ($PE_{Biomass,CH4,y}$)

Emissions from this source are calculated as follows:

$$\mathrm{PE}_{\mathrm{Biomass\ ,CH\,4,y}} = \mathrm{EF}_{\mathrm{CH\,4,BF}} \times \sum_{\mathrm{k}} \mathrm{BF}_{\mathrm{k,y}} \times \mathrm{NCV}_{\mathrm{k}}$$

where:

$BF_{k,y}$ = Quantity of biomass residue type *k* combusted in the project plant during the year *y* (tonnes of dry matter)

NCV_k = Net calorific value of the biomass residue type *k* (GJ/ton of dry matter)

$EF_{CH4,BF}$ = CH_4 emission factor for the combustion of biomass residues in the project plant (tCH_4/GJ)

Conservativeness factor of 1.37 is multiplied by $PE_{Biomass,CH4,y}$ for providing conservative estimate of this value as described in table 4 and 5 (EFB is classified as garden waste by the IPCC) of the methodology ACM0006. CH_4 emission factor of 41.1kg/TJ is used for this calculation.

Emission reduction due to displacement of electricity

$$\mathrm{ER}_{\mathrm{electricity\ ,y}} = \mathrm{EG}_{\mathrm{y}} \times \mathrm{EF}_{\mathrm{electricity\ ,y}}$$

where,

EG_y = Net quantity of increased electricity generation as a result of the project activity (incremental to baseline generation) during the year *y* (MWh)

$EF_{electricity,y}$ = CO_2 emission factor for the electricity displaced due to the project activity during the year *y* (tCO_2/MWh)

Determination of $EF_{electricity,y}$

The emission factor of the grid electricity was determined using the “Study on Grid Connected Electricity Baselines in Malaysia Year 2006 and 2007”. Combined margin of the 2007 emissions figures are used.

$EF_{electricity,y}$ = 0.873tCO_2/MWh

Emission reduction due to displacement of electricity is calculated using the methodology ACM0006 and not ACM0014 although this methodology could accounts for replacement of grid electricity, since the CFB boiler use both biomass and biogas to generate electricity. The renewable electricity generated from the project activity derives from both biomass and biogas, thus the amount of electricity that replaces grid electricity, which is calculated in ACM0006 also contains the electricity generated from the biogas (i.e. ACM0014). Therefore, in order to prevent double counting, only the ACM0006 was used to calculate the emission reductions due from the displacement of the grid electricity.

Determination of EG_y

EG_y corresponds to the lower value between (a) the net quantity of electricity generated in the new power plant that is installed as part of the project activity ($EG_{project\ plant,y}$) and (b) the difference between the total net electricity generation from firing the same type(s) of biomass residues at the project site ($EG_{total,y}$), based on the three most recent years, as follows:

$$EG_y = MIN\left\{\begin{matrix} EG_{project\ \ plant\ ,y} \\ EG_{total\ ,y} - \frac{EG_{historic\ \ ,3yr}}{3} \end{matrix}\right\}$$

where:

EG_y = Net quantity of increased electricity generation as a result of the project activity (incremental to baseline generation) during the year y (MWh/yr)

$EG_{project\ plant,y}$ =Net quantity of electricity generated in the project plant during the year y (MWh/yr)

$EG_{total,y}$ =Net quantity of electricity generated in all power plant, including the new power plant installed as part of the project activity and any previously existing plants, during the year y (MWh/yr)

$EG_{historic,3yr}$ =Net quantity of electricity generated during the most recent three years in all power plants at the project site, generated from firing the same type(s) of biomass residues as used in the project plant (MWh)

Emission reduction or increases due to displacement of heat

$$Q_y = MIN\left\{\begin{matrix} Q_{project\ \ plant\ ,y} \\ Q_{total\ ,y} - \frac{Q_{historic\ \ ,3yr}}{3} \end{matrix}\right\} - \frac{Q_{biomass\ \ ,historic\ \ ,3yr}}{3}$$

where:

$ER_{heat,y}$ =Emission reductions due to displacement of heat during the year *y* (tCO_2/yr)

Q_y =Quantity of increased heat generation in the project plant (incremental to heat generation in any existing cogeneration plants) that displaces heat generation in fossil fuel fired boilers during the year *y* (GJ/yr)

$Q_{project\ plant,y}$ =Net quantity of heat generated in the cogeneration project plant from firing biomass residues during the year y (GJ)

$Q_{total,y}$ =Net quantity of heat generated in all cogeneration plants at the project site, generated from firing the same type(s) of biomass residues as in the project plant, including the cogeneration plant installed as part of the project activity and any previously existing plants, during the year *y* (GJ)

$Q_{historic,3yr}$ = Net quantity of heat generated during the most recent three years in all cogeneration plants at the project site, generated from firing the same type(s) of biomass residues as in the project plant (GJ)

$Q_{biomass,historic,3yr}$ =Net quantity of heat generated during the most recent three years in all boilers at the project site, generated from firing the same type(s) of biomass residues as in the project plant (GJ)

ε_{boiler} =Energy efficiency of the boiler that would be used in the absence of the project activity

$EF_{CO2,BL,heat}$ =CO_2 emission factor of the fossil fuel type used for heat generation in the absence of the project activity (tCO_2/GJ)

All the fuel used for the cogeneration plant are biomass residues, therefore Q_y=0, which is also conservative approach. $Q_{biomass,historic,3yr}$ shall not be determined as a parameter as there is no need for it.

Baseline emissions due to natural decay or uncontrolled burning of anthropogenic sources of biomass residues

Step 1. Determination of the quantity of biomass residues used as a result of the project activity ($BF_{PJ,k,y}$)

$BF_{PJ,k,y}$ =Incremental quantity of biomass residue type k used as a result of the project activity in the project plant during the year *y* (tons of dry matter or liter)

EFB is the only biomass residue that is being dumped and left to decay, which is described in the baseline scenario. Thus, the quantity of EFB consumed for the project activity would be equivalent to the quantity of $BF_{PJ,k,y.}$

Step2. Estimation of methane emissions, consistent with the baseline scenario for the use of biomass residues

The project assumes all EFB are dumped into SWDS, but in case of any EFB that is left decay in an aerobic condition or burned in an uncontrolled manner, it shall be monitored and calculated using the following equation:

$$BE_{biomass,y} = BE_{burn,biomass,y} + BE_{CH4,SWDS,y}$$

where:

$BE_{biomass,y}$ = Baseline emissions due to natural decay or burning of anthropogenic sources of biomass residues during the year y (tCO_2e/yr)

$BE_{burn,biomass,y}$ =Baseline emissions due to uncontrolled burning or aerobic decay of the biomass residues (tCO_2e/yr)

$BE_{CH4,SWDS,y}$ =Baseline emissions due to anaerobic decay of the biomass residues (tCO_2e/yr)

Uncontrolled burning or aerobic decay of the biomass residues

$$BE_{biomass,y} = GWP_{CH4} \times \Sigma BF_{PJ,k,y} \times NCV_k \times EF_{burning,CH4,k,y}$$

where:

GWP_{CH4} =Global Warming Potential of methane valid for the commitment period (tCO_2e/tCH_4)

$BF_{PJ,k,y}$ =Incremental quantity of biomass residue type k used as a result of the project activity in the project plant during the year *y* (tons of dry matter or liter)

NCV_k =Net calorific value of the biomass residue type k (GJ/ton of dry matter or GJ/liter)

$EF_{burning,CH4,k,y}$ =CH_4 emission factor for uncontrolled burning of the biomass residue type *k* during the year *y* (tCH_4/GJ)

k =Types of biomass residues for which the identified baseline scenario is B1 or B3 and for which leakage effects could be ruled out with one of the approaches L_1, L_2, L_3 described in the leakage section

Anaerobic decay of the biomass residue

$$BE_{CH\,4,SWDS\,,y} = \varphi \times (1 - f) \times GWP_{CH\,4} \times (1 - OX) \times \frac{16}{12} \times F \times DOC_f \times MCF \times \sum_{x-1}^{y} \sum_{j} W_{j,x} \times DOC_j \times e^{-k_j(y-x)} \times \left(1 - e^{-kj}\right)$$

where:

Φ = The model correction factor to account for model uncertainties (0.9)

F = The fraction of methane captured at the SWDS and flared, combusted or used in another manner

$GWP_{CH\,4}$ = The Global Warming Potential of methane valid for the commitment period (tCO_2e/tCH_4)

OX = The oxidation factor (reflecting the amount of methane from SWDS that is oxidised in the soil or other material covering the waste)

16/12 = The conversion factor for carbon (C) to methane (CH_4)

F = The fraction of methane in the SWDS gas (volume fraction) (0.5)

DOC_f = The fraction of degradable organic carbon (DOC) that can decompose

MCF = The methane correction factor

$W_{j,x}$ = The amount of organic waste type *j* prevented from disposal in the SWDS in the year *x* (tonnes)

DOC_j = The fraction of degradable organic carbon (by weight) in the waste type *j*

k_j = The decay rate for the waste type *j*

j = The waste type category

x = The year during the crediting period: *x* runs from the first year of the first crediting period (x = 1) to the year *y* for which avoided emissions are calculated

y = The year for which methane emissions are calculated

Leakage

The main potential source of leakage for this project activity is an increase in emissions from fossil fuel combustion or other sources due to diversion of biomass residues from other uses to the project plant as a result of the project activity.

The project activity is required to demonstrate that the use of EFB does not result in increased fossil fuel consumption elsewhere. This project shall use L_2 to demonstrate that there is an abundant surplus of the biomass residue in the region of the project activity which is not utilized. The boundary of the project activity shall be defined as Sarawak state. It must be demonstrated that the quantity of available biomass reside of type k in the region is at least 25% larger than the quantity of biomass residues of type k that are utilized (e.g. for energy generation or as feedstock), including the project plant.

According to the MPOB, Malaysian Palm Oil Board's statistics, State of Sarawak's FFB production is 7.797 million tons in year 2007. Then mass of EFB is thought to be 23% of FFB, hence the EFB residue could be estimated to be 1.793 million tons/year.
The project activity is expected to utilise 144,000 tons of EFB from its operation. This accounts for8 % of total EFB amount and that stipulates the impacts of the project activity for diversion of EFB use is not recognizable as a leakage.

If the leakage effects cannot be ruled out with the L_2 option described in the methodology, leakage effects for the year y shall be calculated as follows:

$$L_y = EF_{CO\,2,LE} \times \sum_k BF_{PJ,k,y} \times NCV_k$$

where:
L_y = Leakage emissions during the year *y* (tCO_2/yr)
$EF_{CO\,2,LE}$ = CO_2 emission factor of the most carbon intensive fuel used in the country (tCO_2/GJ)
$BF_{PJ,k,y}$ = Incremental quantity of biomass residue type *k* used as a result of the project activity in the project plants during the year *y* (tonnes)
K = Types of biomass residues for which leakage effects could not be ruled out
NCV_k = Net calorific value of the biomass residue type *k* (GJ/ton of dry matter)

ACM0014 Emission reduction calculation

Baseline emissions

Baseline emissions are estimated as follows:

$$BE_y = BE_{CH4,y} + BE_{EL,y} + BE_{HG,y}$$

where:

BE_y = Baseline emissions in year *y* (tCO_2e / yr)

$BE_{CH4,y}$ = Methane emissions from anaerobic treatment of the wastewater in open lagoons (scenario 1) or the anaerobic treatment of sludge in sludge pits (scenario 2) in the absence of the project activity in year *y* (tCO_2e / yr)

$BE_{EL,y}$ = CO_2 emissions associated with electricity generation that is displaced by the project activity and/or electricity consumption in the absence of the project activity in year *y* (tCO_2 / yr)

$BE_{HG,y}$ = CO_2 emissions associated with fossil fuel combustion for heating equipment that is displaced by the project in year *y* (tCO_2 / yr)

The methodology proposes two alternative methods for the estimation of methane emissions from open lagoons:

(a) The Methane Conversion Factor Method (described in Step 1a); and
(b) The Organic Removal Ratio Method (described in Step 1b).

Methane Conversion Factor Method shall be implemented for this project activity.

Step1: Calculation of baseline emissions from anaerobic treatment of the wastewater
Step1a: Methane Conversion Factor Method

Methane conversion factor method shall be used for the calculation of this project activity.

The baseline methane emissions from anaerobic treatment of the wastewater in open lagoons is estimated based on the chemical oxygen demand (COD) of the wastewater that would enter the lagoon in the absence of the project activity ($COD_{PJ,y}$), the maximum methane producing capacity (B_o) and a methane conversion factor ($MCF_{BL,y}$) which expresses the proportion of the wastewater that would decay to methane, as follows:

$$BE_{CH4,y} = GWP_{CH4} \times MCF_{BL,y} \times B_0 \times COD_{BL,y}$$

where:

$BE_{CH4,y}$ = Methane emissions from anaerobic treatment of the wastewater in open lagoons in the absence of the project activity in year *y* (tCO_2e / yr)

GWP_{CH4} = Global Warming Potential of methane valid for the commitment period (tCO_2e / tCH_4)

B_0 = Maximum methane producing capacity, expressing the maximum amount of CH_4 that can be produced from a given quantity of chemical oxygen demand (tCH_4 / tCOD)

$MCF_{BL,y}$ = Average baseline methane conversion factor (fraction) in year *y*, representing the fraction of ($COD_{PJ,y}$ x B_0) that would be degraded to CH_4 in the absence of the project activity

$\mathrm{COD}_{\mathrm{BL,y}}$ = Quantity of chemical oxygen demand that would be treated in open lagoons in the absence of the project activity in year *y* (tCOD / yr)

Determination of $\mathrm{COD}_{BL,y}$

In principle, the baseline chemical oxygen demand ($\mathrm{COD}_{\mathrm{BL,y}}$) corresponds to the chemical oxygen demand that is treated under the project activity ($\mathrm{COD}_{\mathrm{PJ,y}}$) because the wastewater treated under the project activity would in the absence of the project activity be directed to the open lagoon, and thus $\mathrm{COD}_{\mathrm{BL,y}} = \mathrm{COD}_{\mathrm{PJ,y}}$.

If there would be an effluent from the lagoons in the baseline, $\mathrm{COD}_{\mathrm{BL}}$ should be adjusted by an effluent adjustment factor which relates the COD supplied to the lagoon or sludge pit with the COD in the effluent, as follows:

$$\mathrm{COD}_{\mathrm{BL,y}} = \mathrm{AD}_{\mathrm{BL}} \times \mathrm{COD}_{\mathrm{PJ,y}}$$

Where:

$\mathrm{COD}_{\mathrm{BL,y}}$ = Quantity of chemical oxygen demand that would be treated in open lagoons (scenario 1) or in sludge pits (scenario 2) in the absence of the project activity in year *y* (tCOD / yr)

$\mathrm{AD}_{\mathrm{BL}}$ = Effluent adjustment factor expression the percentage of COD that is degraded in open lagoons (scenario 1) or in sludge pits (scenario 2) in the absence of the project activity

$\mathrm{COD}_{\mathrm{PJ,y}}$ = Quantity of chemical oxygen demand that is treated in the anaerobic digester or under clearly aerobic conditions in the project activity in year *y* (tCOD / yr)

$\mathrm{AD}_{\mathrm{BL}}$ is determined as follows:

For project activities implemented in existing facilities:

(a) In the case when at least one year historical data of the COD inflow and COD effluent are available, $\mathrm{AD}_{\mathrm{BL}}$ should be determined as follows:

$$\mathrm{AD}_{\mathrm{BL}} = 1 - \frac{\mathrm{COD}_{\mathrm{out,x}}}{\mathrm{COD}_{\mathrm{in,x}}}$$

Where:

$\mathrm{AD}_{\mathrm{BL}}$ = Effluent adjustment factor expression the percentage of COD that is degraded in open lagoons (scenario 1) or in sludge pits (scenario 2) in the absence of the project activity

$\mathrm{COD}_{\mathrm{out,x}}$ = COD of the effluent in the period *x* (tCOD)

$\mathrm{COD}_{\mathrm{in,x}}$ = COD directed to the open lagoons (scenario 1) or in sludge pits (scenario 2) in the period *x* (tCOD)

X = Representative historical reference period (at least one year)

(b) In the case when at least one year historical data of the COD inflow and COD effluent are not available, $\mathrm{AD}_{\mathrm{BL}}$ should be determined as follows:

> $\mathrm{AD}_{\mathrm{BL}}$ is determined by conducting measurements of the COD inflow to and effluent from the lagoon or sludge pit during a measurement campaign of at least 10 days. The measurements should be undertaken during a period that is representative for the typical operation conditions

of the plant and ambient conditions of the site (temperature, etc). The average COD_{in} and COD_{out} values from the measurement campaign shall be used for the calculation and the result shall be multiplied by 0.89 to account for the uncertainty range (of 30% to 50%) associated with this approach as compared to one-year historical data.

This project activity does not have one year historical data, thus 10 days COD measurement is carried out.

Determination of $MCF_{BL,y}$

The quantity of methane generated from COD disposed to the open lagoon depends mainly on the temperature and the depth of the lagoon or sludge pit. Accordingly, the methane conversion factor is calculated based on a factor f_d, expressing the influence of the depth of the lagoon or sludge pit on methane generation, and a factor $f_{T,y}$ expressing the influence of the temperature on the methane generation. In addition, a conservativeness factor of 0.89 is applied to account for the considerable uncertainty associated with this approach. $MCF_{BL,y}$ is calculated as follows:

$$\mathrm{MCF}_{\mathrm{BL,y}} = \mathrm{f_d} \times \mathrm{f}_{\mathrm{T,y}} \times 0.89$$

where:

$\mathrm{MCF}_{\mathrm{BL,y}}$ = Average baseline methane conversion factor (fraction) in year *y*, representing the fraction of ($COD_{PJ,y}$ x B_0) that would be degraded to CH_4 in the absence of the project activity

$\mathrm{f_d}$ = Factor expressing the influence of the depth of the lagoon or sludge pit on methane generation

$\mathrm{f}_{\mathrm{T,y}}$ = Factor expressing the influence of the temperature on the methane generation in year *y*

0.89 = Conservativeness factor

Determination of $f_{T,y}$

In some regions, the ambient temperature varies significantly over the year. Therefore, the factor $f_{T,y}$ is calculated with the help of a monthly stock change model which aims at assessing how much COD degrades in each month. For each month *m*, the quantity of wastewater directed to the lagoon or sludge directed to a pit, the quantity of organic compounds that decay and the quantity of any effluent water from the lagoon is balanced, giving the quantity of COD that is available for degradation in the next month: The amount of organic matter available for degradation to methane ($COD_{available,m}$) is assumed to be equal to the amount of organic matter directed to the open lagoon or sludge pit, less any effluent, plus the COD that may have remained in the lagoon or sludge pit from previous months, as follows:

$$\mathrm{COD}_{\mathrm{available\ ,m}} = \mathrm{COD}_{\mathrm{BL,m}} + \left(1 - \mathrm{f}_{\mathrm{T,m}}\right) \times \mathrm{COD}_{\mathrm{available\ ,m-1}} \quad \text{with}$$

$$\mathrm{COD}_{\mathrm{BL,m}} = \mathrm{AD}_{\mathrm{BL}} \times \mathrm{COD}_{\mathrm{PJ,m}} \quad \text{and}$$

$$\mathrm{COD}_{\mathrm{PJ,m}} = \mathrm{F}_{\mathrm{PJ,dig,m}} \times \mathrm{w}_{\mathrm{COD\ ,dig\ ,m}}$$

where:

$COD_{available,m}$ = Quantity of chemical oxygen demand available for degradation in the open lagoon or sludge pit in month *m* (t COD / month)

$COD_{BL,m}$ = Quantity of chemical oxygen demand that would be treated in open lagoons in the absence of the project activity in month *m* (t COD / month)

$COD_{PJ,m}$ = Quantity of chemical oxygen demand that is treated in the anaerobic digester or under clearly aerobic conditions in the project activity in month *m* (t COD / month)

AD_{BL} = Effluent adjustment factor expressing the percentage of COD that is degraded in open lagoons in the absence of the project activity

$F_{PJ,dig,m}$ = Quantity of wastewater or sludge that is treated in the anaerobic digester or under clearly aerobic conditions in the project activity in month *m* (m^3 / month)

$w_{COD,dig,m}$ = Average chemical oxygen demand in the wastewater or sludge that is treated in the anaerobic digester or under clearly aerobic conditions in the project activity in month *m* (t COD / m^3)

$f_{T,m}$ = Factor expressing the influence of the temperature on the methane generation in month *m*

m = Months of year *y* of the crediting period

The carry -over calculations are limited to a maximum of one year. In case the residence time in the open lagoon is less than one year, carry-on calculations are limited to the period where the wastewater remains in the lagoon or the sludge remains in the sludge pit. i.e., in the case of the emptying of a sludge pit, the accumulation of organic matter restarts with the next inflow and the COD available from the previous month should be set to zero. Project participants should provide evidence of the typical residence time of the organic matter in the lagoon or the sludge pit.

The monthly factor to account for the influence of the temperature on methane generation is calculated based on the following "van't Hoff – Arrhenius" approach:

$$f_{T,m} = \begin{cases} 0 \quad \text{if } T_{2,m} < 283K \\ \exp^{\left(\frac{E*(T_{2,m}-T_1)}{R*T_1*T_{2,m}}\right)} \quad \text{if } 283K < T_{2,m} < 303K \\ 1 \quad \text{if } T_{2,m} > 303K \end{cases}$$

where:

$f_{T,m}$ = Factor expressing the influence of the temperature on the methane generation in month *m*

E = Activation energy constant (15,175 cal / mol)

$T_{2,m}$ = Average temperature at the project site in month *m* (K)

T_1 = 303.16 K (273.16 K + 30 K)

R = Ideal gas constant (1.987 cal / K mol)

m = Months of year *y* of the crediting period

As indicated in equation (10) above, the value of $f_{T,m}$ cannot exceed 1 and should be assumed to be zero if the ambient temperature is below 10°C.

Based on the monthly values $f_{T,m}$ the annual value $f_{T,y}$ is calculated as follows:

$$f_{T,y} = \frac{\sum_{m=1}^{12} f_{T,m} \times COD_{availabl\ e,m}}{\sum_{m=1}^{12} COD_{BL,m}}$$

where:

$f_{T,y}$ = Factor expressing the influence of the temperature on the methane generation in year *y*

$f_{T,m}$ = Factor expressing the influence of the temperature on the methane generation in month *m*

$COD_{available\ ,m}$ = Quantity of chemical oxygen demand available for degradation in the open lagoon or sludge pit in month *m* (t COD / month)

$COD_{BL,m}$ = Quantity of chemical oxygen demand that would be treated in open lagoons (Scenario 1) or in sludge pits (Scenario 2) in the absence of the project activity in month *m* (t COD / month)

M = Months of year *y* of the crediting period

Step 2: Baseline emissions from generation and/or consumption of electricity

In this step, baseline emissions from the following sources are estimated:

- Baseline emissions from consumption of electricity associated with the treatment of wastewater;

If electricity is generated with biogas from a new anaerobic digester under the project activity: baseline emissions from the generation of electricity in the grid (E2) and / or with a captive fossil fuel fired power plant (E1) in the absence of the electricity generation with biogas.

As a simplification, project participants may neglect one or both emission sources. Baseline emissions from the generation and / or consumption of electricity are calculated as follows:

$$BE_{EL,y} = (EC_{BL,y} + EG_{PJ,y}) \times EF_{BL,EL,y}$$

where:

$BE_{EL,y}$ = CO_2 emissions associated with electricity generation that is displaced by the project activity and / or electricity consumption in the absence of the project activity in year *y* (tCO_2 / yr)

$EC_{BL,y}$ = Annual quantity of electricity that would be consumed in the absence of the project activity for the treatment of the wastewater (Scenario 1) or the treatment of the sludge (Scenario 2) (MWh / yr)

$EG_{PJ,y}$ = Net quantity of electricity generated in year *y* with biogas from the new anaerobic biodigester (MWh / yr)

$EF_{BL,EL,y}$ = Baseline emission factor for electricity generated and / or consumed in the absence of the project activity in year *y* (tCO_2 / MWh)

The determination of $EF_{BL,EL,y}$ depends on the baseline scenario and the configuration at the project site. The grid emission factor should be used ($EF_{BL,EL,y} = EF_{grid,y}$)

The displacement of grid electricity has been already calculated using the methodology ACM0006 therefore:

$EF_{BL,EL,y} = EF_{grid,y} = 0$

Step3: Baseline emissions from the generation of heat

For scenario H3, baseline emissions from the generation of heat is zero as described in the methodology ACM0014.

$BE_{HG,y} = 0$

where:

$BE_{HG,y}$ = CO2 emissions associated with fossil fuel combustion for heating equipment that is displaced by the project in year *y* (t CO_2 / yr)

Project emissions

Emissions attributed to the project activity depend on which scenario in Table 1 applies and the configuration of the project activity.

(i) Methane emissions from the lagoons or dewatering process (applicable if effluent from the treatment under the project activity is directed to either a lagoon system or to a dewatering facility);

In the case of project activities that introduce an anaerobic digester for the treatment of wastewater or sludge:

(ii) Physical leakage of methane from the digester system;

(iii) Methane emissions from flaring (applicable if biogas from the digester is flared);

In the case of projects that introduce a treatment of sludge:

(iv) Methane and nitrous oxide emissions from land application of sludge (if applicable); In the case of projects that consume electricity or heat under the project activity:

(v) CO_2 emissions from consumption of electricity and or fossil fuels in the project activity.

Project participants should document and justify in the CDM-PDD which emission sources are applicable in the context of their project activity. Project emissions are calculated as follows:

$$PE_y = PE_{CH4,effluent,y} + PE_{CH4,digest,y} + PE_{flare,y} + PE_{sludge,LA,y} + PE_{EC,y} + PE_{FC,y}$$

where:

PE_y = Project emissions in year *y* (tCO_2e / yr)

$PE_{CH4,effluent,y}$ = Project emissions from treatment of wastewater effluent from the anaerobic digester in year *y* (tCO_2e / yr)

$PE_{CH4,digest,y}$ = Project emissions from physical leakage of methane from the anaerobic digester in year *y* (tCO_2e / yr)

$PE_{flare,y}$ = Project emissions from flaring of biogas generated in the anaerobic digester in year *y* (tCO_2e / yr)

$PE_{sludge,LA,y}$ = Project emissions from land application of sludge in year *y* (tCO_2e / yr)

$PE_{EC,y}$ = Project emissions from electricity consumption in year *y* (tCO_2e / yr)

$PE_{FC,y}$ = Project emissions from fossil fuel consumption in year *y* (tCO_2e / yr)

(i) Project methane emissions from effluent from the digester

This step is applicable if a new digester is installed under the project activity and if the effluent from this digester is directed to open lagoons or a dewatering facility (see Scenario 1 and Scenario 2, project activity b in Table 1 of the Applicability conditions).

A significant amount of the COD load is usually degraded in the new anaerobic digester and open lagoons can be expected to operate under largely aerobic conditions. However, due to the uncertainty regarding the exact extent of aerobic / anaerobic degradation after project implementation, the calculation of any CH_4 emissions is conservatively carried out in the same way as for the baseline, using either the methane conversion factor method or the organic removal ratio method. The same method as for the baseline emissions shall be applied.

For the project activity, methane conversion factor method is used to calculate the project methane emission from the treatment of the POME.

Methane conversion factor method

Project methane emissions from treatment of the effluent from the digester are estimated as follows:

$$\mathrm{PE}_{\mathrm{CH4,effluent},y} = \mathrm{GWP}_{\mathrm{CH4}} \times \mathrm{MCF}_{\mathrm{PJ},y} \times \mathrm{B}_0 \times \left(\mathrm{COD}_{\mathrm{PJ,effl,dig},y} - \mathrm{COD}_{\mathrm{PJ,effl,lag},y}\right) \text{ with}$$

$$\mathrm{COD}_{\mathrm{PJ,effl,dig},y} = \sum_{m=1}^{12} \mathrm{F}_{\mathrm{PJ,effl,dig},m} \times \mathrm{w}_{\mathrm{COD,effl,dig},m} \text{ and}$$

$$\mathrm{COD}_{\mathrm{PJ,effl,lag},y} = \sum_{m=1}^{12} \mathrm{F}_{\mathrm{PJ,effl,lag},m} \times \mathrm{w}_{\mathrm{COD,effl,lag},m}$$

where:

$\mathrm{PE}_{\mathrm{CH4,effluent},y}$ = Project emissions from treatment of wastewater effluent from the anaerobic digester in year *y* (tCO_2e / yr)

$\mathrm{GWP}_{\mathrm{CH4}}$ = Global Warming Potential of methane valid for the commitment period (tCO_2e / tCH_4)

$\mathrm{MCF}_{\mathrm{PJ},y}$ = Project methane conversion factor (fraction) in year *y*, representing the fraction of ($COD_{PJ,effluent,y}$ x B_0) that degrades to CH_4

B_0 = Maximum methane producing capacity, expressing the maximum amount of CH_4 that can be produced from a given quantity of chemical oxygen demand (tCH_4 / tCOD)

$\mathrm{COD}_{\mathrm{PJ,effl,dig},y}$ = Quantity of chemical oxygen demand in the effluent from the digester in year *y* (tCOD / yr)

$\mathrm{COD}_{\mathrm{PJ,effl,lag},y}$ = Quantity of chemical oxygen demand in the effluent of the open lagoon or dewatering facility in which the effluent from the digester is treated in year *y* (tCOD / yr)

$\mathrm{F}_{\mathrm{PJ,effl,dig},m}$ = Quantity of effluent from the digester in month *m* (m^3 / month)

$\mathrm{w}_{\mathrm{COD,effl,dig},m}$ = Average chemical oxygen demand in the effluent from the digester in month *m* (tCOD / m^3)

$\mathrm{F}_{\mathrm{PJ,effl,lag},m}$ = Quantity of effluent from the open lagoon or dewatering facility in which the effluent from the digester is treated in month *m* (m^3 / month)

$\mathrm{w}_{\mathrm{COD,effl,lag},m}$ = Average chemical oxygen demand in the effluent from the open lagoon or dewatering facility in which the effluent from the digester is treated in month *m* (tCOD / m^3)

The quantity of methane generated from COD disposed to the open lagoon or in dewatering facility is calculated as follows:

$$\mathrm{MCF}_{\mathrm{PJ},y} = \mathrm{f}_{\mathrm{d}} \times \mathrm{f}_{\mathrm{PJ,T},y}$$

where:

$MCF_{PJ,y}$ = Project methane conversion factor (fraction) in year *y*, representing the fraction of ($COD_{PJ,effluent,y}$ x B_o) that degrades to CH_4

f_d = Factor expressing the influence of the depth of the lagoon or dewatering facility on methane generation

$f_{PJ,T,y}$ = Factor expression the influence of the temperature on the methane generation under the project activity in year *y*

The factor $f_{T,PJ,y}$ is calculated, as under baseline emissions, with the help of a monthly stock change model which aims at assessing how much COD degrades in each month, as follows:

$$COD_{PJ,available\ ,m} = (COD_{PJ,effl,dig,m} - COD_{PJ,effl,lag,m}) + (1 - f_{T,m}) \times COD_{PJ,available\ ,m-1}$$

with

$COD_{PJ,effl,dig,y} = F_{PJ,effl,dig,m} \times w_{COD,effl,dig,m}$ and

$COD_{PJ,effl,lag,y} = F_{PJ,effl,lag,m} \times w_{COD,effl,lag,m}$

where:

$COD_{PJ,available\ ,m}$ = Quantity of chemical oxygen demand available for degradation in the open lagoon or dewatering facility under the project activity in month *m* (tCOD / month)

$COD_{PJ,effl,dig,m}$ = Quantity of chemical oxygen demand in the effluent from the digester in month *m* (tCOD / month)

$COD_{PJ,effl,lag,m}$ = Quantity of chemical oxygen demand in the effluent of the open lagoon or dewatering facility in which the effluent from the digester is treated in month *m* (tCOD / month)

$F_{PJ,effl,dig,m}$ Quantity of effluent from the digester in month *m* (m^3 / month)

$w_{COD,effl,dig,m}$ = Average chemical oxygen demand in the effluent from the digester in month *m* (tCOD / m^3)

$F_{PJ,effl,lag,m}$ = Quantity of effluent from the open lagoon or dewatering facility in which the effluent from the digester is treated in month *m* (m^3 / month)

$w_{COD,effl,lag,m}$ = Average chemical oxygen demand in the effluent from the open lagoon or dewatering facility in which the effluent from the digester is treated in month *m* (tCOD / m^3)

$f_{T,m}$ = Factor expressing the influence of the temperature on the methane generation in month *m*

m = Months of year *y* of the crediting period

As for the baseline emissions, the carry-over calculations are limited to a maximum of one year. In case the residence time in the open lagoon or the dewatering facility is less than one year, carry-on calculations are limited to the period where the wastewater remains in the lagoon or dewatering facility.

Project participants should provide evidence of the typical residence time of the organic matter in the lagoon or the dewatering facility.

The monthly factor to account for the influence of the temperature on methane generation is calculated as per equation above.

Based on the monthly values $f_{T,m}$ the annual value $f_{T,PJ,y}$ is calculated as follows:

$$f_{PJ,T,y} = \frac{\sum_{m=1}^{12} f_{T,m} \times COD_{PJ,available\ ,m}}{\sum_{m=1}^{12}\left(COD_{PJ,effl\ ,dig\ ,m} - COD_{PJ,effl\ ,lag\ ,m}\right)}$$

where:

$f_{PJ,T,y}$	= Factor expressing the influence of the temperature on the methane generation under the project activity in year *y*
$f_{T,m}$	= Factor expressing the influence of the temperature on the methane generation in month *m*
$COD_{PJ,available\ ,m}$	= Quantity of chemical oxygen demand available for degradation in the open lagoon or dewatering facility under the project activity in month *m* (tCOD / month)
$COD_{PJ,effl\ ,dig\ ,m}$	= Quantity of chemical oxygen demand in the effluent from the digester in month *m* (tCOD / month)
$COD_{PJ,effl\ ,lag\ ,m}$	= Quantity of chemical oxygen demand in the effluent of the open lagoon or dewatering facility in which the effluent from the digester is treated in month *m* (tCOD / month)
M	= Months of year *y* of the crediting period

(ii) Project emissions related to physical leakage from the digester

The project involves the construction of a new anaerobic digester. The emissions directly associated with the operation of digesters involve the physical leakage of methane form the digester system. Methane emissions form the new digester are calculated as follows:

$$PE_{CH4,digest,y} = F_{biogas,y} x\ EF_{CH4,digest} x\ w_{CH4,digest}\ x\ GWP_{CH4} x\ 0.001$$

where:

$PE_{CH4,digest}$	= Project emissions from physical leakage of methane from the digester (tCO_2e/yr)
$F_{biogas,y}$	= Amount of biogas collected in the outlet of the new digester in year y (m^3/yr)
$EF_{CH4,digest}$	= Fraction of biogas that leaks from digester (m^3 biogas leaked/m^3 biogas produced)
$w_{CH4,digest}$	= Concentration of methane in the biogas in the outlet of the new digester (kg CH_4/m^3)

(iii) Methane emissions from flaring

Calculation of annual project emissions from flaring

Project emissions from flaring are calculated as the sum of emissions from each hour h, based on the methane flow rate in the residual gas ($TM_{RG,h}$) and the flare efficiency during each hour h ($\eta_{flare,h}$), as follows:

$$PE_{flare,y} = \sum_{h=1}^{8760} TM_{RG,h} \times \left(1 - \eta_{flare,h}\right) \times \frac{GWP_{CH4}}{1000}$$

where:

$PE_{flare,y}$ = Project emissions from flaring of the residual gas stream in year, *y* (tCO_2e)

$TM_{RG,h}$ = Mass flow rate of methane in the residual gas in the hour *h* (kg/h)

$\eta_{flare,h}$ = Flare efficiency in hour *h*

The quantity of methane in the residual gas flowing into the flare is the product of the volumetric flow rate of the residual gas ($FV_{RG,h}$), the volumetric fraction of methane in the residual gas ($fv_{CH4,RG,h}$) and the density of methane ($\rho_{CH4,n,h}$) in the same reference conditions (normal condition and dry or wet basis).

$$TM_{RG,h} = FV_{RG,h} \times fv_{CH4,RG,h} \times \rho_{CH4,n}$$

where:

$TM_{RG,h}$ = Mass flow rate of methane in the residual gas in the hour h (kg/h)

$FV_{RG,h}$ = Volumetric flow rate of the residual gas in dry basis at normal conditions in hour h (m^3/h)

$fv_{CH4,RG,h}$ = Volumetric fraction of methane in the residual gas on dry basis in hour h

$\rho_{CH4,n}$ = Density of methane at normal conditions (0.716 kg/m^3)

The project plans to use an enclosed flare. The default value of 90% is used for the flare efficiency as described in the methodological tool.

(iv) Project emissions from land application of sludge

The project does not involve the application of the sludge to the land.
In case of any sludge application, the amount will be monitored and counted as project emission using the following formula:

$$PE_{sludge,LA,y} = COD_{sludge,LA,y} \times B_0 \times MCF_{sludge,LA} \times GWP_{CH4} + S_{LA,y} \times w_{N,sludge,y} \times EF_{N2O,LA,sludge} \times GWP_{N2O}$$

where:

$PE_{sludge,LA,y}$ = Project emissions from land application of sludge in year *y* (tCO_2e / yr)

$COD_{sludge,LA,y}$ = Chemical oxygen demand (COD) of the sludge applied to land after the dewatering process in year *y* (tCOD / yr)

$MCF_{sludge,LA}$ = Methane conversion factor for the application of sludge to lands

GWP_{CH4} = Global Warming Potential of methane valid for the applicable commitment period (tCO_2e / tCH_4)

$S_{LA,y}$ = Amount of sludge applied to land in year *y* (t / yr)

$w_{N,sludge,y}$ = Mass fraction of nitrogen in the sludge applied to land in year *y* (tN / tsludge)

$EF_{N2O,LA,sludge}$ = N_2O emission factor for nitrogen from sludge applied to land (tN_2O / tN)

GWP_{N2O} = Global Warming Potential of nitrous dioxide (tCO_2e / tN_2O)

(v) Project emissions from electricity consumption and combustion of fossil fuels in the project

No fossil fuel or electricity that is derived from fossil fuel is being planned to be used for this project activity, thus this project emission is not applicable.

Leakage

No leakage is estimated

Emission Reductions

Emission reductions for any given year of the crediting period are calculated by subtracting project emissions from baseline emissions.

$ER_y = BE_y - PE_y$

ER_y = Emissions reductions of the project activity in year *y* (tCO_2e/yr)

BE_y = Baseline emissions in year *y* (tCO_2e/yr)

PE_y = Project emissions in year *y* (tCO_2e/yr)

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

Data and parameters that are available at validation for ACM0006

Data / Parameter:	**GWP_{CH4}**
Data unit:	tCO_2e/tCH_4
Description:	Global warming potential for CH_4
Source of data used:	2006 IPCC Guidelines
Value applied:	21
Justification of the choice of data or description of measurement methods and procedures actually applied :	21 for the first commitment period. Shall be updated according to any future COP/MOP decisions.
Any comment:	-

Data / Parameter:	**$EF_{CH4,BF}$**
Data unit:	tCH4/GJ
Description:	CH_4 emission factor for the combustion of biomass residues in the project plant
Source of data used:	Methodology ACM0006 table 4 and 5
Value applied:	0.0000411

Justification of the choice of data or description of measurement methods and procedures actually applied :	EFB is considered as a wood waste or other solid biomass residues with a assumed uncertainty of over 300%, so conservative factor of 1.37 must be multiplied by the default CH_4 emission factor of 30kg/TJ as described in the table 4 and 5, and also as a given example of methodology ACM0006.
Any comment:	This parameter is for the calculation of CO_2 emission from electricity consumption

Data / Parameter:	Φ
Data unit:	-
Description:	The model correction factor to account for model uncertainties
Source of data used:	Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site
Value applied:	0.9
Justification of the choice of data or description of measurement methods and procedures actually applied :	As described in the Methodological tool
Any comment:	This parameter is for the calculation of CO_2 emission from electricity consumption

Data / Parameter:	**OX**
Data unit:	Fraction
Description:	Oxidation factor (reflecting the amount of methane from SWDS that is oxidised in the soil or other material covering the waste)
Source of data used:	Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site
Value applied:	0
Justification of the choice of data or description of measurement methods and procedures actually applied :	As described in the Methodological tool No oxidising material was used to cover the SWDS
Any comment:	-

Data / Parameter:	**F**
Data unit:	-
Description:	Fraction of methane in the SWDS gas (volume fraction)
Source of data used:	Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site
Value applied:	0.5
Justification of the choice of data or	As described in the Methodological tool

description of measurement methods and procedures actually applied :	
Any comment:	-

Data / Parameter:	**DOC_f**
Data unit:	-
Description:	Fraction of degradable organic carbon (DOC) that can decompose
Source of data used:	Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site
Value applied:	0.5
Justification of the choice of data or description of measurement methods and procedures actually applied :	As described in the Methodological tool
Any comment:	-

Data / Parameter:	**MCF**
Data unit:	-
Description:	Methane correction factor
Source of data used:	Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site
Value applied:	0.8
Justification of the choice of data or description of measurement methods and procedures actually applied :	As described in the Methodological tool Value selected for unmanaged solid waste disposal sites – deep and/or with higher water table.
Any comment:	-

Data / Parameter:	**DOC_j**
Data unit:	-
Description:	Fraction of degradable organic carbon (by weight) in the waste type *j*
Source of data used:	Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site
Value applied:	0.20
Justification of the choice of data or description of measurement methods and procedures actually applied :	As described in the Methodological tool EFB was identified as similar to Garden waste (wet waste) as described in the methodological tool.
Any comment:	-

Data / Parameter:	**k_j**
Data unit:	-
Description:	Decay rate for the waste type *j*
Source of data used:	Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site
Value applied:	0.17
Justification of the choice of data or description of measurement methods and procedures actually applied :	As described in the Methodological tool EFB was identified as similar to Garden waste (tropical and wet) as described in the methodological tool.
Any comment:	-

Data and parameters that are available at validation for ACM0014

Data / Parameter:	**- $COD_{out,x}$** **- $COD_{in,x}$**
Data unit:	mg/l
Description:	- COD of the effluent in period x - COD directed to the open lagoons in the period x
Source of data used:	COD inflow to and effluent from the lagoon during a measurement campaign of 10 days.
Value applied:	- 8,800 - 88,000
Justification of the choice of data or description of measurement methods and procedures actually applied :	There was no one year historical data was available, thus measurement of COD inflow and outflow was conducted over period of 10 days.
Any comment:	x = Representative historical reference period of 10 days

Data / Parameter:	**B_o**
Data unit:	$tCH_4/tCOD$
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:	2006 IPCC Guidelines
Value applied:	0.21
Justification of the choice of data or description of measurement methods and procedures actually applied :	No measurement procedures. The default IPCC value for B_o is 0.25 kg CH_4/kg COD. If the methodology is used for wastewater containing materials not akin to simple sugars, a CH4 emissions factor different from 0.21 $tCH_4/tCOD$ has to be estimated and applied.

Any comment:	The value, 0.21 kgCH_4/kgCOD was used for conservative assumption

Data / Parameter:	**f_d**
Data unit:	-
Description:	Factor expressing the influence of the depth of the lagoon on methane generation
Source of data used:	As described in the methodology ACM0014
Value applied:	50%
Justification of the choice of data or description of measurement methods and procedures actually applied :	The lagoons have a depth of 1-5m.
Any comment:	Applicable to the methane conversion factor method.

Data / Parameter:	**D**
Data unit:	M
Description:	Average depth of the lagoon
Source of data used:	Measurement of the lagoons
Value applied:	4.26
Justification of the choice of data or description of measurement methods and procedures actually applied :	The depths of all of the lagoons were measured.
Any comment:	Applicable to the methane conversion factor method.

Data / Parameter:	**EC_{BL}**
Data unit:	MWh/year
Description:	Annual quantity of electricity that would be consumed in the absence of the project activity for the treatment of the wastewater (scenario 1)
Source of data used:	Historical Records
Value applied:	0
Justification of the choice of data or description of measurement methods and procedures actually applied :	The treatment of the wastewater does not consume any electricity.
Any comment:	-

Data / Parameter:	**GWP_{CH4}**
Data unit:	tCO_2e/tCH_4

Description:	Global Warming Potential for CH_4
Source of data used:	IPCC
Value applied:	21
Justification of the choice of data or description of measurement methods and procedures actually applied :	Default to be applied for the first commitment period.
Any comment:	Shall be updated according to any future COP/MOP decisions

Data / Parameter:	**GWP_{N2O}**
Data unit:	tCO_2e/tN_2O
Description:	Global Warming Potential for N_2O
Source of data used:	IPCC
Value applied:	296
Justification of the choice of data or description of measurement methods and procedures actually applied :	Default to be applied: 296 for the first commitment period
Any comment:	Shall be updated according to any future COP/MOP decisions

Data / Parameter:	**A**
Data unit:	Unit of area (ha)
Description:	Surface area of the lagoon
Source of data used:	Actual measurements of existing lagoons
Value applied:	6.1812
Justification of the choice of data or description of measurement methods and procedures actually applied :	-
Any comment:	-

Data / Parameter:	**ρ_{CH4}**
Data unit:	kg/m^3
Description:	Density of methane at normal conditions
Source of data used:	Tool to determine project emissions from flaring gases containing methane
Value applied:	0.716
Justification of the choice of data or description of	As described in the methodological tool

measurement methods and procedures actually applied :	
Any comment:	-

Data / Parameter:	**Flare efficiency**
Data unit:	%
Description:	Flare efficiency
Source of data used:	Tool to determine project emissions from flaring gases containing methane
Value applied:	0.90
Justification of the choice of data or description of measurement methods and procedures actually applied :	Enclosed flare shall be installed for the project activity, thus the default value of 90% from the methodological tool was used.
Any comment:	-

B.6.3 Ex-ante calculation of emission reductions:

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ACM0006 Emission reduction calculation

Future projection of the FFB processing (tonnes)

		Biomass residues			
Y	FFB	Fibre (k_1)	Shell (k_2)	EFB (k_3)	Total amount of the biomass residues
2011	350,000	62,895	27,300	81,900	172,095
2012	435,000	78,170	33,930	101,790	213,890
2013	500,000	89,850	39,000	117,000	245,850
2014	500,000	89,850	39,000	117,000	245,850
2015	500,000	89,850	39,000	117,000	245,850
2016	500,000	89,850	39,000	117,000	245,850
2017	500,000	89,850	39,000	117,000	245,850
2018	500,000	89,850	39,000	117,000	245,850
2019	500,000	89,850	39,000	117,000	245,850
2020	500,000	89,850	39,000	117,000	245,850

Ex-ante calculation is based on this FFB processing projection

Project Emissions

No transportation of the biomass residues to the project site using a vehicle is considered, since all of the biomass would be provided from the Selangau palm oil mill. Also no fossil fuel or electricity derived from fossil fuel is expected to be used during the project activity, therefore:

$PET_y=0$
$PEFF_y=0$
$PE_{EC,y}=0$

Methane emission from electricity combustion of biomass residues ($PE_{Biomass,CH4,y}$)

Calculation of $PE_{Biomass,CH4,y}$

Y	【Fiber】 $EF_{CH4,BF}$ $\times BF_{k1,y}$ (tCH_4)	【Shell】 $EF_{CH4,BF}$ $\times BF_{k2,y}$ (tCH_4)	【EFB】 $EF_{CH4,BF}$ $\times BF_{k3,y}$ (tCH_4)	Total (tCH_4)	$PE_{Biomass,CH4,y}$ (tCO_2e)
2011	34.63	21.14	27.06	82.83	1,739.46
2012	43.04	26.27	33.63	102.95	2,161.90
2013	49.48	30.20	38.66	118.33	2,484.95
2014	49.48	30.20	38.66	118.33	2,484.95
2015	49.48	30.20	38.66	118.33	2,484.95
2016	49.48	30.20	38.66	118.33	2,484.95
2017	49.48	30.20	38.66	118.33	2,484.95
2018	49.48	30.20	38.66	118.33	2,484.95
2019	49.48	30.20	38.66	118.33	2,484.95
2020	49.48	30.20	38.66	118.33	2,484.95

Calculation of project emissions (tCO_2e)

y	PET_y	$PEFF_y$	$PE_{EC,y}$	$PE_{Biomass,CH4,y}$	PE_y
2011	0	0	0	1739.46	1739.46
2012	0	0	0	2161.90	2161.90
2013	0	0	0	2484.95	2484.95
2014	0	0	0	2484.95	2484.95
2015	0	0	0	2484.95	2484.95
2016	0	0	0	2484.95	2484.95
2017	0	0	0	2484.95	2484.95
2018	0	0	0	2484.95	2484.95
2019	0	0	0	2484.95	2484.95
2020	0	0	0	2484.95	2484.95

Emission reduction due to displacement of electricity

Y	$EF_{grid,y}$ (MWh)	EG_y (MWh)	$ER_{electricity,y}$ (tCO_2e)
2011	64,691	64,691	56,476
2012	84,096	84,096	73,416
2013	98,935	98,935	86,370
2014	98,935	98,935	86,370
2015	98,935	98,935	86,370
2016	98,935	98,935	86,370
2017	98,935	98,935	86,370
2018	98,935	98,935	86,370
2019	98,935	98,935	86,370
2020	98,935	98,935	86,370

Emission reduction or increases due to displacement of heat

Q_y=0

Baseline emissions due to natural decay or uncontrolled burning of anthropogenic sources of biomass residues

Step 1. Determination of the quantity of biomass residues used as a result of the project activity

See the EFB generation data from the table: Future projection of the FFB processing.

Step2. Estimation of methane emissions, consistent with the baseline scenario for the use of biomass residues

The calculation of the methane emission is available in Annex 3

Emission Reductions

See B. 6.4.

ACM0014 Emission reduction calculation

The future POME production is calculated from the FFB production projection.

Year	FFB production (t/yr)	POME production (t/yr)
2011	350,000	338,800
2012	435,000	421,080
2013	500,000	484,000
2014	500,000	484,000
2015	500,000	484,000
2016	500,000	484,000
2017	500,000	484,000
2018	500,000	484,000
2019	500,000	484,000
2020	500,000	484,000

Baseline emissions

Step1: Calculation of baseline emissions from anaerobic treatment of the wastewater
Step1a: Methane Conversion Factor Method

Year 2011

Month	℃	K	$f_{T,m}$	$F_{PJ,dig,m}$	$COD_{PJ,m}$	COD_{BLM}	$COD_{available,m}$	$f_{T,m}$ ×COD available
1	27	300.16	0.78	28,233.33	2,484.53	1,990.11	2,433.08	1,891.51
2	26	299.16	0.71	28,233.33	2,484.53	1,990.11	3,255.02	2,324.18
3	26	299.16	0.71	28,233.33	2,484.53	1,990.11	3,490.07	2,492.01
4	27	300.16	0.78	28,233.33	2,484.53	1,990.11	3,209.93	2,495.44
5	28	301.16	0.85	28,233.33	2,484.53	1,990.11	2,791.19	2,361.20
6	27	300.16	0.78	28,233.33	2,484.53	1,990.11	3,054.37	2,374.50
7	26	299.16	0.71	28,233.33	2,484.53	1,990.11	3,432.69	2,451.04
8	27	300.16	0.78	28,233.33	2,484.53	1,990.11	3,197.16	2,485.51
9	27	300.16	0.78	28,233.33	2,484.53	1,990.11	3,144.73	2,444.75
10	27	300.16	0.78	28,233.33	2,484.53	1,990.11	3,133.06	2,435.68
11	27	300.16	0.78	28,233.33	2,484.53	1,990.11	3,130.46	2,433.66
12	26	299.16	0.71	28,233.33	2,484.53	1,990.11	3,454.45	2,466.58
					Total	**23,881.33**	**Total**	**28,656.07**

$BE_{CH4,2011}=21\times0.534\times0.21\times23881.33=56236$

Year 2012

Month	℃	K	$f_{T,m}$	$F_{PJ,dig,m}$	$COD_{PJ,m}$	COD_{BLM}	COD $_{available,m}$	$f_{T,m}$ ×COD available
1	27	300.16	0.78	35,090.00	3,087.92	2,473.42	3,023.98	2,350.88
2	26	299.16	0.71	35,090.00	3,087.92	2,473.42	4,045.53	2,888.62
3	26	299.16	0.71	35,090.00	3,087.92	2,473.42	4,337.66	3,097.21
4	27	300.16	0.78	35,090.00	3,087.92	2,473.42	3,989.48	3,101.48
5	28	301.16	0.85	35,090.00	3,087.92	2,473.42	3,469.05	2,934.64
6	27	300.16	0.78	35,090.00	3,087.92	2,473.42	3,796.14	2,951.17
7	26	299.16	0.71	35,090.00	3,087.92	2,473.42	4,266.35	3,046.29
8	27	300.16	0.78	35,090.00	3,087.92	2,473.42	3,973.61	3,089.14
9	27	300.16	0.78	35,090.00	3,087.92	2,473.42	3,908.45	3,038.48
10	27	300.16	0.78	35,090.00	3,087.92	2,473.42	3,893.95	3,027.20
11	27	300.16	0.78	35,090.00	3,087.92	2,473.42	3,890.72	3,024.69
12	26	299.16	0.71	35,090.00	3,087.92	2,473.42	4,293.39	3,065.60
					Total	**29,681.09**	**Total**	**35,615.40**

$BE_{CH4,2011}$=21×0.534×0.21×29,681.09=69,893

2013-2020 (annual figure)

Month	℃	K	$f_{T,m}$	$F_{PJ,dig,m}$	$COD_{PJ,m}$	COD_{BLM}	COD $_{available,m}$	$f_{T,m}$ ×COD available
1	27	300.16	0.78	40,333.33	3,549.33	2,843.02	3,475.83	2,702.16
2	26	299.16	0.71	40,333.33	3,549.33	2,843.02	4,650.03	3,320.25
3	26	299.16	0.71	40,333.33	3,549.33	2,843.02	4,985.82	3,560.01
4	27	300.16	0.78	40,333.33	3,549.33	2,843.02	4,585.61	3,564.92
5	28	301.16	0.85	40,333.33	3,549.33	2,843.02	3,987.42	3,373.14
6	27	300.16	0.78	40,333.33	3,549.33	2,843.02	4,363.38	3,392.15
7	26	299.16	0.71	40,333.33	3,549.33	2,843.02	4,903.85	3,501.48
8	27	300.16	0.78	40,333.33	3,549.33	2,843.02	4,567.37	3,550.73
9	27	300.16	0.78	40,333.33	3,549.33	2,843.02	4,492.47	3,492.51
10	27	300.16	0.78	40,333.33	3,549.33	2,843.02	4,475.80	3,479.55
11	27	300.16	0.78	40,333.33	3,549.33	2,843.02	4,472.09	3,476.66
12	26	299.16	0.71	40,333.33	3,549.33	2,843.02	4,934.93	3,523.68
					Total	**34,116.19**	**total**	**40,937.24**

$BE_{CH4,2013-20}$=21×0.534×0.21×34,116.19=80,337

Step 2: Baseline emissions from generation and/or consumption of electricity

The baseline emissions from generation of electricity results in replacement of the grid electricity generated by fossil fuel. This electricity is already been accounted for by the methodology ACM0014 of this project activity, thus in order to prevent double counting, baseline emissions is calculated as 0 for this methodology.

Step3: Baseline emissions from the generation of heat

$BE_{HG,y}$ =0

Project emissions

(vi) Project methane emissions from effluent from the digester

Methane conversion factor method

See Annex 3 for the calculations.

(vii) Project emissions related to physical leakage from the digester

The digester is designed to avoid physical leakage, therefore the ex-ante calculation assumes.

$PE_{CH4,digest,y} = 0$

(viii) Methane emissions from flaring

Calculation of annual project emissions from flaring

For the monitoring of the project activity, “Tool to determine project emissions from flaring gases containing Methane” is used, for the ex-ante calculation it is assumed that 5% of the biogas is being flared and a flare efficiency of 90% (enclosed flare).

$PE_{flare,y} = F_{biogas,y} \times 5\% \times w_{CH4digest} \times (1\text{-flare efficiency}) \times GWP_{CH4}$

Y	Biogas flared (m^3N/year)	Project Emission from flaring (tCO_2e)
2011	115094000	5,184
2012	143045400	6,443
2013	164420000	7,406

(ix) Project emissions from land application of sludge

The project activity is not planning to utilise the sludge for land application, therefore the ex-ante calculation assumes 0 for this, value however any land application of the sludge would be monitored and accounted during the crediting period.

(x) Project emissions from electricity consumption and combustion of fossil fuels in the project

No fossil fuel or electricity derived from fossil fuel is being planned to be used for this project activity, thus this project emission is not applicable.

Emission Reductions

See B.6.4

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

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ACM0006 emission reduction (tCO_2e)

y	$ER_{heat,y}$ **(a)**	$ER_{electricity,y}$ **(b)**	$BE_{biomass,y}$ **(c)**	PE_y **(d)**	ER_y **(a+b+c-d)**
2011	0	56,476	12,906	1,739	67,642
2012	0	73,416	26,929	2,162	98,183
2013	0	86,370	41,157	2,485	125,042
2014	0	86,370	53,160	2,485	137,045
2015	0	86,370	63,287	2,485	147,172
2016	0	86,370	71,830	2,485	155,716
2017	0	86,370	79,038	2,485	162,923
2018	0	86,370	85,119	2,485	169,005
2019	0	86,370	90,250	2,485	174,135
2020	0	86,370	94,578	2,485	178,463

ACM 0014 Emissions Reduction (tCO_2e)

y	BE_y **(a)**			PE_y **(b)**						ER_y **(a-b)**
	BE_{CH4}	$BE_{EL,y}$	$BE_{HG,y}$	$PE_{CH4,effluent,y}$	$PE_{CH4,digest,y}$	$PE_{flare,y}$	$PE_{sludge,LA,y}$	$PE_{EC,y}$	$PE_{FC,y}$	
2011	56,236	0	0	24,760	0	5,184	0	0	0	26,292
2012	69,893	0	0	30,773	0	6,443	0	0	0	32,677
2013	80,337	0	0	35,372	0	7,406	0	0	0	37,559
2014	80,337	0	0	35,372	0	7,406	0	0	0	37,559
2015	80,337	0	0	35,372	0	7,406	0	0	0	37,559
2016	80,337	0	0	35,372	0	7,406	0	0	0	37,559
2017	80,337	0	0	35,372	0	7,406	0	0	0	37,559
2018	80,337	0	0	35,372	0	7,406	0	0	0	37,559
2019	80,337	0	0	35,372	0	7,406	0	0	0	37,559
2020	80,337	0	0	35,372	0	7,406	0	0	0	37,559

Total emission reductions (tCO_2e)

y	ACM0006 Emission Reductions **(a)**	ACM0014 Emission Reductions **(b)**	Total Emission Reductions **(a+b)**
2011	67,642	26,292	93,934
2012	98,183	32,677	130,860
2013	125,042	37,559	162,601
2014	137,045	37,559	174,605
2015	147,172	37,559	184,731
2016	155,716	37,559	193,275
2017	162,923	37,559	200,483
2018	169,005	37,559	206,564
2019	174,135	37,559	211,694
2020	178,463	37,559	216,023
Total	**1,415,326**	**359,443**	**1,774,770**
Annual average	**141,533**	**35,944**	**177,477**

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

B.7.1 Data and parameters monitored:

Data and parameters monitored for ACM0006

Data / Parameter:	**$BF_{k,y}$**
Data unit:	tons of dry matter or liter
Description:	Quantity of biomass residue type *k* combusted in the project plant during the year *y*
Source of data to be used:	On-site measurements
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Quantity of biomass residues expected to be produced during the crediting period (tonnes/year)
Description of measurement methods and procedures to be applied:	Monitored continuously, energy balance is prepared annually

Year	Fibre (k_1)	Shell (k_2)	EFB (k_3)
2011	62,895	27,300	81,900
2012	78,170	33,930	101,790
2013-2020	89,850	39,000	117,000

QA/QC procedures to be applied:	Crosscheck the measurements with an annual energy balance that is based on purchased quantities and stock changes
Any comment:	-

Data / Parameter:	**$BF_{T,k,y}$**
Data unit:	tons of dry matter or liter
Description:	Quantity of biomass residue type *k* that has been transported to the project site during the year *y* where *k* are the types of biomass residues used in the project plant in year *y*
Source of data to be used:	On-site measurements
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Transportation of biomass residues is not planned Applies only for contingency
Description of measurement methods and procedures to be applied:	Use weight or volume meters.
QA/QC procedures to be applied:	Crosscheck the measurements with an annual energy balance that is based on purchased quantities and stock changes
Any comment:	-

Data / Parameter:	**Moisture content of the biomass residues**
Data unit:	% Water content
Description:	Moisture content of each biomass residue type *k*
Source of data to be used:	On-site measurements
Value of data applied for the purpose of calculating expected emission reductions in section B.5	-
Description of measurement methods and procedures to be applied:	Continuously monitored. Mean values are calculated at least annually
QA/QC procedures to be applied:	-
Any comment:	-

Data / Parameter:	**AVD_y**
Data unit:	Km
Description:	Average round trip distance (from and to) between biomass fuel supply sites and the project site
Source of data to be	Records by projects participants on the origin of the biomass

used:	
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Transportation of biomass residues is not planned Applied only for contingency
Description of measurement methods and procedures to be applied:	Records by project participants on the origin of the biomass
QA/QC procedures to be applied:	Check consistency of distance records provided by the truckers by comparing recorded distances with other information form other sources (e.g. maps)
Any comment:	-

Data / Parameter:	**N_y**
Data unit:	-
Description:	Number of track trips for the transportation of biomass
Source of data to be used:	On-site measurements
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Transportation of biomass residues is not planned Applied only for contingency
Description of measurement methods and procedures to be applied:	-
QA/QC procedures to be applied:	-
Any comment:	-

Data / Parameter:	**TL_y**
Data unit:	Tons of liter
Description:	Average truck load of the trucks used for transportation of Biomass
Source of data to be used:	On-site measurements
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Transportation of biomass residues is not planned Applied only for contingency
Description of measurement methods and procedures to be applied:	-
QA/QC procedures to	-

be applied:	
Any comment:	-

Data / Parameter:	**$EF_{km,CO2,y}$**
Data unit:	tCO_2/km
Description:	Average truck load of the trucks used for transportation of Biomass
Source of data to be used:	On-site measurements
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Transportation of biomass residues is not planned Applied only for contingency
Description of measurement methods and procedures to be applied:	-
QA/QC procedures to be applied:	-
Any comment:	-

<table>
<tr><td>Data / Parameter:</td><td>$EG_{project\ plant,\ y}$</td></tr>
<tr><td>Data unit:</td><td>MWh/yr</td></tr>
<tr><td>Description:</td><td>Net quantity of electricity generated in the project plant during the year y</td></tr>
<tr><td>Source of data to be used:</td><td>On-site measurements</td></tr>
<tr><td>Value of data applied for the purpose of calculating expected emission reductions in section B.5</td><td><table><tr><th>Year</th><th>MWh total</th></tr><tr><td>2011</td><td>64,691</td></tr><tr><td>2012</td><td>84,096</td></tr><tr><td>2013-2020</td><td>98,935</td></tr></table></td></tr>
<tr><td>Description of measurement methods and procedures to be applied:</td><td>Monitored continuously</td></tr>
<tr><td>QA/QC procedures to be applied:</td><td>The consistency of metered net electricity generation should be cross-checked with receipts from the electricity sales (if available) and the quantity of fuels fired (e.g. check whether the electricity generation divided by the quantity of fuels fired results in a reasonable efficiency that is comparable to previous years)</td></tr>
<tr><td>Any comment:</td><td></td></tr>
</table>

Data / Parameter:	**$EG_{total,y}$**
Data unit:	MWh/yr
Description:	Net quantity of electricity generated in all power plants at the project site,

	generated from firing the same type(s) of biomass residues as in the project plant, including the new power plant installed as part of the project activity and any previously existing plans, during the year y.
Source of data to be used:	On-site measurements
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Same as $EG_{project\ plant,y}$
Description of measurement methods and procedures to be applied:	-
QA/QC procedures to be applied:	-
Any comment:	-

Data / Parameter:	**$Q_{project\ plant,\ y}$**
Data unit:	GJ
Description:	Net quantity of heat generated from firing biomass in the project plant.
Source of data to be used:	-
Value of data applied for the purpose of calculating expected emission reductions in section B.5	-
Description of measurement methods and procedures to be applied:	-
QA/QC procedures to be applied:	-
Any comment:	-

Data / Parameter:	**$Q_{total,y}$**
Data unit:	GJ
Description:	Net quantity of heat generated in all cogeneration plants at the project site, generated from firing the same type of biomass residues as in the project plant, including the cogeneration plant installed as part of the project activity and any previously existing plants, during year y.
Source of data to be used:	On-site measurements.
Value of data applied for the purpose of calculating expected	-

emission reductions in section B.5	
Description of measurement methods and procedures to be applied:	-
QA/QC procedures to be applied:	-
Any comment:	-

Data / Parameter:	**NCV_i**
Data unit:	GJ/mass or volume unit
Description:	Net calorific value of the fossil fuel type i
Source of data to be used:	-
Value of data applied for the purpose of calculating expected emission reductions in section B.5	-
Description of measurement methods and procedures to be applied:	Either conduct measurements or use accurate and reliable local or national data where available, where such data is not available, use IPCC default net calorific values (country-specific, if available) if they are deemed to reasonably represent local circumstances. Choose the values in a conservative manner and justify the choice.
QA/QC procedures to be applied:	-
Any comment:	-

Data / Parameter:	**NCV_k**
Data unit:	GJ/ton of dry matter or GJ/liter
Description:	Net calorific value of biomass residues type k
Source of data to be used:	Measurements
Value of data applied for the purpose of calculating expected emission reductions in section B.5	<table><tr><th>Fuel</th><th>LHV</th></tr><tr><td>EFB(post-treatment)</td><td>5,700kcal/kg</td></tr><tr><td>Fibre</td><td>3,200kcal/kg</td></tr><tr><td>Shell</td><td>4,500kcal/kg</td></tr></table>
Description of measurement methods and procedures to be applied:	-
QA/QC procedures to be applied:	-
Any comment:	-

Data / Parameter:	**$EF_{burning, CH4,k,y}$**
Data unit:	tCH4/GJ
Description:	CH4 emission factor for uncontrolled burning of the biomass residue type k during year y
Source of data to be used:	Undertake measurements or use referenced and reliable default values (e.g. IPCC)
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0.0000411tCH_4/GJ
Description of measurement methods and procedures to be applied:	-
QA/QC procedures to be applied:	-
Any comment:	As described in ACM0006 project emission calculation

Data / Parameter:	**-**
Data unit:	Tons
Description:	Quantity of biomass residues of type k that are utilized (e.g. for energy generation or as a feedstock) in the defined geographical region
Source of data to be used:	Surveys or statistics
Value of data applied for the purpose of calculating expected emission reductions in section B.5	-
Description of measurement methods and procedures to be applied:	-
QA/QC procedures to be applied:	-
Any comment:	-

Data / Parameter:	**-**
Data unit:	Tons
Description:	Quantity of available biomass residues of type k in the region
Source of data to be used:	Surveys or statistics
Value of data applied for the purpose of calculating expected	-

emission reductions in section B.5	
Description of measurement methods and procedures to be applied:	-
QA/QC procedures to be applied:	-
Any comment:	-

Data / Parameter:	**$EC_{PJ,y}$**
Data unit:	MWh
Description:	On-site electricity consumption attributable to the project activity during the year y
Source of data to be used:	On-site measurements
Value of data applied for the purpose of calculating expected emission reductions in section B.5	-
Description of measurement methods and procedures to be applied:	-
QA/QC procedures to be applied:	-
Any comment:	-

Data / Parameter:	**$EF_{grid,y}$**
Data unit:	tCO2/MWh
Description:	CO2 emission factor for grid electricity during the year y
Source of data to be used:	Use the latest approved version of ACM0002 to calculate the grid emission factor. If the power generation capacity pf the project plant is less or equal to 15MW, project participants may use the average CO2 emission factor of the electricity system, as referred to in option (d) in Step 1 of the baseline determination in ACM0002.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0.873tCO_2/MWh Use the value from "Study on Grid Connected Electricity Baseline in Malaysia Year: 2006 and 2007" published by Pusat Tenaga Malaysia.
Description of measurement methods and procedures to be applied:	-
QA/QC procedures to	-

be applied:	
Any comment:	-

Data / Parameter:	**$BF_{all\ plants,k,y}$**
Data unit:	Tons of dry matter or liter
Description:	Quantity of biomass residues type k combusted in all power plants at the project site during the year y
Source of data to be used:	On-site measurements
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Same as $BF_{k,y}$
Description of measurement methods and procedures to be applied:	-
QA/QC procedures to be applied:	-
Any comment:	-

Data / Parameter:	**$EF_{CO2,LE}$**
Data unit:	tCO2/GJ
Description:	CO2 emission factor of the most carbon intensive fuel used in the country
Source of data to be used:	Identify the most carbon intensive fuel type from the national communication, other literature sources (e.g. IEA). Possibly consult with the national agency responsible for the national communication/GHG inventory. If available, use national default values for the CO2 emission factor. Otherwise, IPCC default values may be used.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	-
Description of measurement methods and procedures to be applied:	-
QA/QC procedures to be applied:	-
Any comment:	-

Data / Parameter:	f
Data unit:	-
Description:	Fraction of methane captured at the SWDS and flared, combusted or used in another manner

Source of data to be used:	Written information from the operator of the solid waste disposal site and/or site visits at the solid waste disposal site
Value of data applied for the purpose of calculating expected emission reductions in section B.5	-
Description of measurement methods and procedures to be applied:	Annually
QA/QC procedures to be applied:	-
Any comment:	

Data / Parameter:	W_x
Data unit:	Tons
Description:	Total amount of organic waste prevented from disposal in year *x* (tons)
Source of data to be used:	Measurements by project participants
Value of data applied for the purpose of calculating expected emission reductions in section B.5	-
Description of measurement methods and procedures to be applied:	Continuously, aggregated at least annually
QA/QC procedures to be applied:	-
Any comment:	-

Data and parameters monitored for ACM0014

Data / Parameter:	$F_{PJ,dig,m}$
Data unit:	m^3 / month
Description:	Quantity of wastewater or sludge that is treated in the anaerobic digester or under
Source of data to be used:	clearly aerobic conditions in the project activity in month *m*
Value of data applied for the purpose of calculating expected emission reductions in	<table><tr><td>Year</td><td>Quantity</td></tr><tr><td>2011</td><td>338,000t/y</td></tr><tr><td>2012</td><td>421,080t/y</td></tr><tr><td>2013-2020</td><td>484,000t/y</td></tr></table>

section B.5	
Description of measurement methods and procedures to be applied:	Measured
QA/QC procedures to be applied:	-
Any comment:	Parameter monitored continuously but aggregated annually for calculations

Data / Parameter:	$w_{COD,dig,m}$
Data unit:	t COD / m³
Description:	Average chemical oxygen demand in the wastewater or sludge that is treated in
Source of data to be used:	the anaerobic digester or under clearly aerobic conditions in the project activity
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0.027t COD/m^3
Description of measurement methods and procedures to be applied:	Measurements in month *m*
QA/QC procedures to be applied:	Measure the COD according to national or international standards
Any comment:	Regularly, calculate average monthly and annual values

Data / Parameter:	$T_{2,m}$
Data unit:	K
Description:	Average temperature at the project site in month *m*
Source of data to be used:	National or regional weather statistics
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Temperature in ℃ Jan: 27, Feb: 26, Mar: 26, Apr: 27, May: 28, Jun: 27, Jul: 26, Aug: 27, Sep: 27, Oct: 27, Nov: 27, Dec: 26 Average temperature of Sibu in 2008. (Source: Department of Metrology, Malaysia) This table was used for the ex-ante calculation of the crediting periods.
Description of measurement methods and procedures to be applied:	Continuously, aggregated in monthly average values
QA/QC procedures to be applied:	-
Any comment:	Applicable for the methane conversion factor method

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
27	26	26	27	28	27	26	27	27	27	27	26

Data / Parameter:	$EG_{PJ,y}$

Data unit:	MWh / year
Description:	Net quantity of electricity generated in year *y* with biogas from the new anaerobic
Source of data to be used:	Measurements
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0 Accounted by ACM0006
Description of measurement methods and procedures to be applied:	Monitored daily
QA/QC procedures to be applied:	-
Any comment:	-

Data / Parameter:	$HG_{PJ,y}$
Data unit:	TJ / year
Description:	Net quantity of heat generated in year *y* with biogas from the new anaerobic Digester
Source of data to be used:	Measured from the heat received by the heated process; else Calculated on the basis if measurement of the volume of biogas captured and used for heat generation multiplied by the methane content of the gas, CV methane, and the efficiency of the boiler during the project (i.e. with biogas)
Value of data applied for the purpose of calculating expected emission reductions in section B.5	-
Description of measurement methods and procedures to be applied:	Monitored daily Parameter monitored continuously but aggregated annually for calculations
QA/QC procedures to be applied:	-
Any comment:	*y* = Year of the project activity *m* = Months of year *y* of the crediting period Note: annual values are derived from the monthly measures (m)

Data / Parameter:	- $F_{PJ,effl,dig,m}$ - $F_{PJ,effl,lag,m}$ - $S_{LA,y}$
Data unit:	m^3 / month
Description:	- Quantity of effluent from the digester in month *m* - Quantity of effluent from the open lagoon or dewatering facility in which the effluent from the digester is treated in month *m*

<table>
<tr><td></td><td>- Quantity of sludge applied to land in year</td></tr>
<tr><td>Source of data to be used:</td><td>Measurements</td></tr>
<tr><td>Value of data applied for the purpose of calculating expected emission reductions in section B.5</td><td>$F_{PJ,effl,dig,m}$ and $F_{PJ,effl,lag,m}$
<table>
<tr><td>Year</td><td>Quantity (m^3/month)</td></tr>
<tr><td>2011</td><td>27,183</td></tr>
<tr><td>2012</td><td>33,785</td></tr>
<tr><td>2013-2020</td><td>38,833</td></tr>
</table></td></tr>
<tr><td>Description of measurement methods and procedures to be applied:</td><td>Measurements
Measure the COD according to national or international standards</td></tr>
<tr><td>QA/QC procedures to be applied:</td><td>-</td></tr>
<tr><td>Any comment:</td><td>-</td></tr>
</table>

Data / Parameter:	- $w_{COD,effl,dig,m}$ - $w_{COD,effl,lag,m}$
Data unit:	t COD / m³
Description:	-Average chemical oxygen demand in the effluent from the digester in month *m* -Average chemical oxygen demand in the effluent from the open lagoon or dewatering facility in which the effluent from the digester is treated in month *m*
Source of data to be used:	Measurements
Value of data applied for the purpose of calculating expected emission reductions in section B.5	$w_{COD,effl,dig,m}$ 0.027 $w_{COD,effl,lag,m}$ 0.0088
Description of measurement methods and procedures to be applied:	Measurements Measure the COD according to national or international standards
QA/QC procedures to be applied:	-
Any comment:	-

Data / Parameter:	wN,sludge,y
Data unit:	m^3 / yr
Description:	Mass fraction of nitrogen in the sludge applied to land in year *y*
Source of data to be used:	Measurements
Value of data applied for the purpose of calculating expected	Monitored in case of any application of sludge on the land

emission reductions in section B.5	
Description of measurement methods and procedures to be applied:	Regularly calculate average monthly and annual values Measured according to national or international standards
QA/QC procedures to be applied:	-
Any comment:	-

Data / Parameter:	$F_{biogas,y}$
Data unit:	m^3 / yr
Description:	Amount of biogas collected in the outlet of the new digester in year *y*
Source of data to be used:	Measured
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Year: 2011 – 5,754,700 m^3/y Year: 2012 – 7,152,270 m^3/y Year: 2013-2020 – 8,221,000 m^3/y
Description of measurement methods and procedures to be applied:	Parameter monitored continuously but aggregated annually for calculations
QA/QC procedures to be applied:	Flow meters will undergo maintenance / calibration subject to appropriate industry standards. The frequency of calibration and control procedures would be different for each application. This maintenance / calibration practice should be clearly stated in the CDM-PDD.
Any comment:	Applied to estimate emissions associated with physical leakage from the digester

Year	m^3/y
2011	5,754,700
2012	7,152,270
2013-2020	8,221,000

Data / Parameter:	$w_{CH4,biogas,y}$
Data unit:	kg CH_4 / m³
Description:	Concentration of methane in the biogas in the outlet of the new digester
Source of data to be used:	Measured using calibrated continuous gas analyser
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0. 429kg CH_4 / m³
Description of measurement methods and procedures to be applied:	Either with continuous analyser or alternatively with periodical measurement at 95% confidence level
QA/QC procedures to	-

be applied:	
Any comment:	-

Data / Parameter:	$FV_{RG,h}$
Data unit:	m^3/hr
Description:	Volumetric flow rate of the residual gas in dry basis at normal conditions in the hour *h*
Source of data to be used:	Measurements using a flow meter
Value of data applied for the purpose of calculating expected emission reductions in section B.5	-
Description of measurement methods and procedures to be applied:	Monitored continuously.
QA/QC procedures to be applied:	-
Any comment:	-

Data / Parameter:	**Flaring in operation**
Data unit:	Hours/year
Description:	Number of hours in a year where flaring is in operation
Source of data to be used:	Measured
Value of data applied for the purpose of calculating expected emission reductions in section B.5	-
Description of measurement methods and procedures to be applied:	Number of hours where flaring is in operation will be monitored continuously, aggregated annually.
QA/QC procedures to be applied:	-
Any comment:	Only applicable in case of use of a default value

Data / Parameter:	$\mathbf{T_{flare}}$
Data unit:	^{0}C
Description:	Temperature in the exhaust gas of the flare
Source of data to be used:	Measured
Value of data applied for the purpose of	-

calculating expected emission reductions in section B.5	
Description of measurement methods and procedures to be applied:	Continuously
QA/QC procedures to be applied:	Thermocouples should be replaced or calibrated every year.
Any comment:	-

B.7.2 Description of the monitoring plan:

\>>

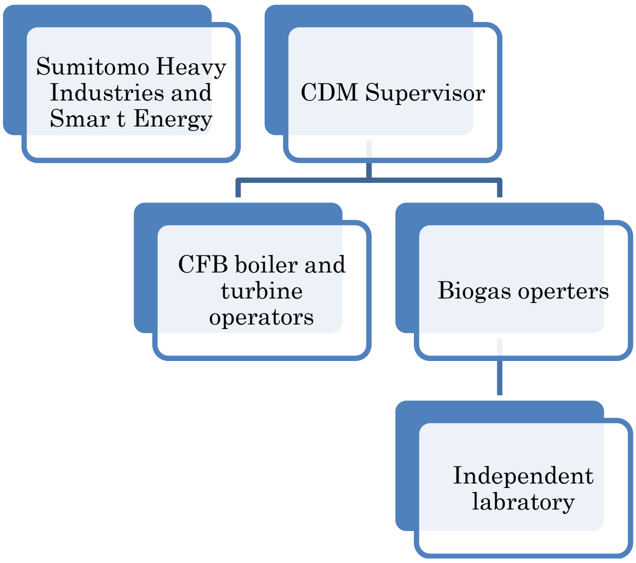
Monitoring management structure

One of the plant managers would be appointed as a supervisor for the CDM. His/her responsibility includes management and operation of the monitoring activities for the CDM.

There would be operators working under the CDM supervisor. They would conduct daily/regular data record, calibrate the apparatus and report the record to the CDM supervisor. There would be operators for the CFB boiler/turbine and for the anaerobic digester. The CFB/turbine operators are mainly responsible for the collecting parameters for the methodology ACM0006 and the biogas operators are mainly responsible for collecting parameters for the methodology ACM0014.

COD value shall be measured by an independent laboratory on a regular basis. The samples are sent to the laboratory by the biogas operators.

Sumitomo Heavy Industries and Smart Energy would assist the development and management of the monitoring system by advising and working together with the CDM supervisor and the operators, especially during the 1st year of the project activity.



Monitoring procedure

The monitoring parameters, monitoring methods and monitoring frequencies are as described in section B.7.1. The daily monitoring data are compiled to monthly data, and the monthly data are compiled into annual data. The data shall be kept in an electronic format and saved as a CDM monitoring database. The database would be maintained by the CDM supervisor. Any incidences of failure of the monitoring apparatus would be recorded in the CDM monitoring database. The database records are kept for at least two years after the end of the crediting period in which the monitoring data were measured and recorded.

Any events that involve the transportation of the biomass residues using trucks, application of the sludge to the land, and any use of fossil fuel for the operation of the power plant including the anaerobic digester shall be monitored and recorded as project emissions.

Quality control and quality assurance procedures

- All of the monitoring apparatus would meet international standards and the level of standard required in the methodologies as described in section B.7.1.
- Regular calibration of the monitoring apparatus would be conducted according to the manufactures' specification.
- Any failure of the apparatus would be recorded.
- Monitoring database would be backed up in a different hardware, which is placed in a secure location.

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

>>

Date of the Completion of the baseline study and monitoring methodology: January 9th, 2009

Name of the responsible person and Entity for above study: Smart Energy Co., Ltd.

(Please refer to contact information in Annex I of this document)

SECTION C. Duration of the project activity / crediting period

C.1 Duration of the project activity:

10 years

C.1.1. Starting date of the project activity:

>>
January 1st, 2011

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

>>
The proposed project operates 15 years of lifetime.

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:

>>
January, 1st, 2011

C.2.2.2. Length:

>>
10 years

SECTION D. Environmental impacts

>>

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

>>

The proposed CDM project site conducted its own environment evaluation prior to its starting operation in 2004. DOE (Department of Environment) of Sarawak State Government does not require an additional environment impact study for the sake of CDM project and site evaluation should be conducted to include environmental aspects for the proposed CDM project. Proposed CDM project takes into account environmental consequences of the palm oil mill operation, in particularly odor from mill waste and noise from power generation plant.

The proposed CDM project can mitigate multiple environmental nuisances including waste water quality, air quality and waste management. The expansion of mill operations increases the road traffic between the mill and the associated plantations. The road conditions of the surrounding areas are being improved as part of the regional development plan, we must alert increase of heavy load truck traffic in vicinity to local parties.

In summary, the project does not have to conduct formal environment impact assessment. However, required site evaluation would be conducted, including environment faucet, before any formal project launching.

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:

>>

The plant requires to conduct and to submit site evaluation report to the state government's Department of Environment. The formal launching of the project will trigger the report drafting.

SECTION E. Stakeholders' comments

>>

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

>>

Comments from the local community and its representatives were collected at the meeting held on 2008 December 11th at the RH Selangau Mill. Followings are the list of participants of the meeting. Through village head, the meeting notice was circulated and people were encouraged to participate. Among 59 households in neighbouring 3 townships, 8 participants attended the meeting where comments on the proposed project were received.

For governmental organizations and administrative bodies, a series of interview were held and comments were collected.

Government Organization

Department of Environment, Sibu Office, State of Sarawak

DOE express its concerns over several environmental aspects of the Selangau plant's operation. Since the plant faced air pollution issue in the past, the air quality issues are the most evident concern. The other concerns are operational aspects of the plant and waste management practices. DOE expects the project to refer to "Environmental Quality Act and Regulations" for its compliance. The DOE does support the project with its positive impacts to the region and its economy.

Sarawak Energy

Sarawak Energy welcomes the project because it contributes to the renewable energy development and is consistent with the SCORE program of the state government. Sarawak Energy particularly supports the project designed to utilize not only biomass waste but also biogas waste in its proposal to fully utilize the biomass energy sources.

E.2. Summary of the comments received:

>>

The community expressed its concerns over the heavy industry development in Selangau Mill and its possible impact on living environment. Followings are outstanding comments and instant replies at the meeting.

What is the technology to be employed by the proposed CDM?
- To explain the introduced technology, attached flyer was offered to participants and explained in details. Participants understood the function of this technology and how it will improve the environment of the community.
- Proponents also explained function of global warming and how it threatens the daily life and share understanding on necessity to address environmental improvements.

How does the technology resolve the environmental concern of the community?
- Brief explanation was made by project proponents.
- Detailed explanation and information session will be held before commence of the project.

What are the tangible benefits that the community can expect from the implementation of this project?
- Proponents explained that the project may generate job opportunity locally for the construction of the new facilities. After commencement, project operations require skilled labour forces. As a result, the project will encourage technology transfer.

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

>>

Selangau plant is planning to hold a session for the community to introduce this applied technology to resolve community's concerns over the potential negative impact of the operation.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

Organization:	Rimbunan Sawit Berhad
Street/P.O.Box:	No. 85&86, Pusat Suria Permata. Jalan Upper Lanang12A
Building:	
City:	Sibu
State/Region:	Sarawak
Postfix/ZIP:	96000
Country:	Malaysia
Telephone:	+60-84-218555
FAX:	+60-84-219555
E-Mail:	rsb@rsb.com.my
URL:	http://www.rsb.com.my/index.html
Represented by:	
Title:	
Salutation:	
Last Name:	
Middle Name:	
First Name:	
Department:	
Mobile:	
Direct FAX:	
Direct tel:	
Personal E-Mail:	

Organization:	Smart Energy Co., Ltd.
Street/P.O.Box:	1-12-14 Toranomon,
Building:	Toranomon Masters Building 3F
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State/Region:	Tokyo
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FAX:	+81-3-3591-3012
E-Mail:	info@smart-energy.jp
URL:	http://www.smart-energy.jp/
Represented by:	
Title:	
Salutation:	
Last Name:	
Middle Name:	
First Name:	
Department:	
Mobile:	

Direct FAX:	
Direct tel:	
Personal E-Mail:	

Annex 2

INFORMATION REGARDING PUBLIC FUNDING

No public funding is involved in proposed project.

Annex 3

BASELINE INFORMATION

ACM0006: Ex-ante calculation of the baseline emission from the biomass residue k_3 (EFB)

crediting period	1	2	3	4	5	6	7	8	9	10
y value	10	10	10	10	10	10	10	10	10	10
x value	10	9	8	7	6	5	4	3	2	1
	12,906	10,889	9,186	7,750	6,539	5,516	4,654	3,926	3,313	2,795
		16,041	13,533	11,417	9,632	8,126	6,856	5,784	4,880	4,117
			18,438	15,555	13,123	11,072	9,341	7,880	6,648	5,609
				18,438	15,555	13,123	11,072	9,341	7,880	6,648
					18,438	15,555	13,123	11,072	9,341	7,880
						18,438	15,555	13,123	11,072	9,341
							18,438	15,555	13,123	11,072
								18,438	15,555	13,123
									18,438	15,555
										18,438
Total	12,906	26,929	41,157	53,160	63,287	71,830	79,038	85,119	90,250	94,578

ACM0014 : Ex-ante calculation for project methane emissions from effluent from the digester for year 2011, 2012, and 2013-2020, using methane conversion factor method.

Year 2011

Month	℃	K	$f_{T,m}$	$F_{PJ,effl,dig,m}$	$F_{PJ,effl,lag,m}$	$w_{COD,effl,dig,m}$	$w_{COD,effl,lag,m}$	$COD_{PJ,effl,dig,m}$	$COD_{PJ,effl,lag,m}$	$COD_{PJ,available,m}$	$f_{T,m}$× $COD_{PJ,available,m}$	$COD_{PJ,effl,dig,m}$- $COD_{PJ,effl,lag,m}$
1	27	300.16	0.78	27,183.33	27,183.33	0.027	0.0088	733.95	239.21	937.71	728.99	494.74
2	26	299.16	0.71	27,183.33	27,183.33	0.027	0.0088	733.95	239.21	1,332.01	951.09	494.74
3	26	299.16	0.71	27,183.33	27,183.33	0.027	0.0088	733.95	239.21	1,444.77	1,031.61	494.74
4	27	300.16	0.78	27,183.33	27,183.33	0.027	0.0088	733.95	239.21	1,259.30	978.99	494.74
5	28	301.16	0.85	27,183.33	27,183.33	0.027	0.0088	733.95	239.21	995.32	841.99	494.74
6	27	300.16	0.78	27,183.33	27,183.33	0.027	0.0088	733.95	239.21	1,159.25	901.22	494.74
7	26	299.16	0.71	27,183.33	27,183.33	0.027	0.0088	733.95	239.21	1,395.37	996.33	494.74
8	27	300.16	0.78	27,183.33	27,183.33	0.027	0.0088	733.95	239.21	1,248.30	970.44	494.74
9	27	300.16	0.78	27,183.33	27,183.33	0.027	0.0088	733.95	239.21	1,215.57	945.00	494.74

10	27	300.16	0.78	27,183.33	27,183.33	0.027	0.0088	733.95	239.21	1,208.28	939.33	494.74
11	27	300.16	0.78	27,183.33	27,183.33	0.027	0.0088	733.95	239.21	1,206.66	938.07	494.74
12	26	299.16	0.71	27,183.33	27,183.33	0.027	0.0088	733.95	239.21	1,408.92	1,006.01	494.74
							total	8,807.40	2,870.56		11,229.07	5,936.84

Year2012

Month	℃	K	$f_{T,m}$	$F_{PJ,effl,dig,m}$	$F_{PJ,effl,lag,m}$	$w_{COD,effl,dig,m}$	$w_{COD,effl,lag,m}$	$COD_{PJ,effl,dig,m}$	$COD_{PJ,effl,lag,m}$	$COD_{PJ,available,m}$	$f_{T,m}\times COD_{PJ,available,m}$	$COD_{PJ,effl,dig,m}-COD_{PJ,effl,lag,m}$
1	27	300.16	0.78	38,833.33	38,833.33	0.027	0.0088	1,048.50	341.73	1,339.59	1,041.41	706.77
2	26	299.16	0.71	38,833.33	38,833.33	0.027	0.0088	1,048.50	341.73	1,902.87	1,358.71	706.77
3	26	299.16	0.71	38,833.33	38,833.33	0.027	0.0088	1,048.50	341.73	2,063.96	1,473.72	706.77
4	27	300.16	0.78	38,833.33	38,833.33	0.027	0.0088	1,048.50	341.73	1,799.00	1,398.56	706.77
5	28	301.16	0.85	38,833.33	38,833.33	0.027	0.0088	1,048.50	341.73	1,421.88	1,202.84	706.77
6	27	300.16	0.78	38,833.33	38,833.33	0.027	0.0088	1,048.50	341.73	1,656.08	1,287.46	706.77
7	26	299.16	0.71	38,833.33	38,833.33	0.027	0.0088	1,048.50	341.73	1,993.38	1,423.33	706.77
8	27	300.16	0.78	38,833.33	38,833.33	0.027	0.0088	1,048.50	341.73	1,783.29	1,386.35	706.77
9	27	300.16	0.78	38,833.33	38,833.33	0.027	0.0088	1,048.50	341.73	1,736.52	1,349.99	706.77
10	27	300.16	0.78	38,833.33	38,833.33	0.027	0.0088	1,048.50	341.73	1,726.11	1,341.90	706.77
11	27	300.16	0.78	38,833.33	38,833.33	0.027	0.0088	1,048.50	341.73	1,723.80	1,340.10	706.77
12	26	299.16	0.71	38,833.33	38,833.33	0.027	0.0088	1,048.50	341.73	2,012.75	1,437.16	706.77
							total	12,582.00	4,100.80		16,041.53	8,481.20

Year 2013-2020 (annual data)

Month	℃	K	$f_{T,m}$	$F_{PJ,effl,dig,m}$	$F_{PJ,effl,lag,m}$	$w_{COD,effl,dig,m}$	$w_{COD,effl,lag,m}$	$COD_{PJ,effl,dig,m}$	$COD_{PJ,effl,lag,m}$	$COD_{PJ,available,m}$	$f_{T,m}\times COD_{PJ,available,m}$	$COD_{PJ,effl,dig,m}-COD_{PJ,effl,lag,m}$
1	27	300.16	0.78	38,833.33	38,833.33	0.027	0.0088	1,048.50	341.73	1,339.59	1,041.41	706.77
2	26	299.16	0.71	38,833.33	38,833.33	0.027	0.0088	1,048.50	341.73	1,902.87	1,358.71	706.77
3	26	299.16	0.71	38,833.33	38,833.33	0.027	0.0088	1,048.50	341.73	2,063.96	1,473.72	706.77
4	27	300.16	0.78	38,833.33	38,833.33	0.027	0.0088	1,048.50	341.73	1,799.00	1,398.56	706.77
5	28	301.16	0.85	38,833.33	38,833.33	0.027	0.0088	1,048.50	341.73	1,421.88	1,202.84	706.77
6	27	300.16	0.78	38,833.33	38,833.33	0.027	0.0088	1,048.50	341.73	1,656.08	1,287.46	706.77
7	26	299.16	0.71	38,833.33	38,833.33	0.027	0.0088	1,048.50	341.73	1,993.38	1,423.33	706.77
8	27	300.16	0.78	38,833.33	38,833.33	0.027	0.0088	1,048.50	341.73	1,783.29	1,386.35	706.77

9	27	300.16	0.78	38,833.33	38,833.33	0.027	0.0088	1,048.50	341.73	1,736.52	1,349.99	706.77
10	27	300.16	0.78	38,833.33	38,833.33	0.027	0.0088	1,048.50	341.73	1,726.11	1,341.90	706.77
11	27	300.16	0.78	38,833.33	38,833.33	0.027	0.0088	1,048.50	341.73	1,723.80	1,340.10	706.77
12	26	299.16	0.71	38,833.33	38,833.33	0.027	0.0088	1,048.50	341.73	2,012.75	1,437.16	706.77
							total	12,582.00	4,100.80		16,041.53	8,481.20

Project methane emissions

y	$fPJ_{,T,y}$	$MCF_{PJ,y}$	$PE_{CH4,effluent,y}$ (tCO_2e/y)
2011	1.891422	0.945711	24760.11
2012	1.891422	0.945711	30773.27
2013-2020 (annual data)	1.891422	0.945711	35371.58

Annex 4

MONITORING INFORMATION

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