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

CONTENTS

Annexes

Revision history of this document

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

SECTION A. General description of small-scale project activity

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

Project title	: Magenko Renewables (Penang) Wastewater Methane Avoidance and Energy Generation Project, Malaysia
Document version	: 2.1
Date of completion	: 03/09/2012

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

United Oil Palm Industries Sdn. Bhd. (UOP) processes fresh fruit brunches (FFB) from cultivated oil palms to produce palm oil. The mill is located at the Nibong Tebal Town, situated on the mainland side of the Penang State in Malaysia, with a FFB processing capacity of 45tonne/hr.

During the palm oil production process, a large quantity of waste materials, including empty fruit brunches (EFB), fibers and shells, wastewater (known as palm oil mill effluent or POME) are produced. POME is a high organic content wastewater, for the baseline scenario, POME is treated in a series of anaerobic open lagoons before discharging to the river.

Magenko Renewables (Penang) Wastewater Methane Avoidance and Energy Generation Project, Malaysia (hereafter referred to as "the Project" or "project activity") developed by Magenko Renewables (Penang) Sdn. Bhd. (Magenko Penang) involves the installation and operation of an anaerobic digester to treat POME, and a biogas recovery system to capture the biogas that is generated from anaerobic digestion. After the anaerobic digestion, the treated POME is sent to the existing open lagoons to further reduce its chemical oxygen demand (COD) level before discharging to the river.

The captured biogas, which comprises methane, carbon dioxide and hydrogen sulphide, is utilized as a clean renewable energy fuel for heat generation. Heat is generated by the gas burner and supplied to the Nibong Tebal Paper Mill (NTPM).

In case of producing excess biogas which is not supplied to the NTPM, UOP has the option to take the biogas for power generation for on-site consumption[1]. Otherwise, the excess biogas will be flared.

In view of this, the Project will therefore be responsible for reduction of CO_2 emission through the two activities below:

i. To reduce methane emission from the existing open lagoons through the capture of biogas in the new wastewater treatment system;
ii. To displace the use of the natural gas at the paper mill by the Project utilizing the recovered biogas for thermal energy production and selling to the paper mill.

The Project is expected to have 39,068 tonnes of CO_2 equivalent greenhouse gases (GHGs) emission reductions per year.

[1] Even though contractually UOP has the option to take any excess biogas, it is considered unlikely that there will be biogas left for UOP given the large captive demand of NTPM. It is noted that this aspect is properly dealt with in the investment analysis.

Contribution to Sustainable Development

The Project contributes in the following ways to the sustainable development of Malaysia:

- Environment
  After the Project implementation, the biogas (consist of methane, CO_2 and hydrogen sulfide) is captured by the closed tank. The COD level of the POME entering the existing open lagoons will be lowered, and thus improves the local air quality by reducing the emission of GHGs and toxic odor gas.

- Economic
  The Project promotes the utilization of renewable energy resources by exporting the recovered methane to the gas burner for heat generation, which is sold to the paper mill. This also helps to reduce the dependency of fossil fuels in the region, by displacing the natural gas originally used with renewable energy source.

- Social
  Both short term and long term jobs are created during the construction and operation of the Project. In addition, the working environment for the mill workers will be improved due to the decrease of bad odor from the open lagoons.

The contribution is also in line with the Malaysian energy policies on sustainable development as defined in the *"Malaysia CDM Information Handbook"*[2].

A.3. Project participants:

Name of Party involved (*) ((host) indicates a host Party)	Private and/or public entity(ies) project participants (*) (as applicable)	Kindly indicate if the Party involved wishes to be considered as project participant (Yes/No)
Malaysia (host)	Magenko Renewables (Penang) Sdn. Bhd.	No
United Kingdom of Great Britain and Northern Ireland	Enerpro Carbon SA	No
(*) In accordance with the CDM modalities and procedures, at the time of making the CDM-PDD public at the stage of validation, a Party involved may or may not have provided its approval. At the time of requesting registration, the approval by the Party(ies) involved is required.		

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

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

A.4.1.1. Host Party(ies):

Malaysia

[2] *"Malaysia CDM Information Handbook"* published by Ministry of Natural Resources and Environment: http://cdm.eib.org.my/up_dir/articles995,article,1261392449,Handbook%20Cover_Final%20Book.pdf

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

Penang State

A.4.1.3. City/Town/Community etc:

Nibong Tebal Town

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

The Project is located at Jalan Bandar Baru, Sungai Kecil, 143 000 Nibong Tebal, Penang, Malaysia. The source generating the wastewater is uniquely identified as the UOP mill, also located at the same address. The geographical coordinates of the Project site are:

North latitude - 5^{o}09'19.26"
East longitude - 100^{o}30'31.23"

Figure 1: Physical location of the Project site[3]

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

The type and categories of the Project are defined using the categorization of Appendix B[4] to the "*Simplified Modalities and Procedures for Small-Scale CDM Project Activities*":

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[3] Data source from http://www.travel.co.ck/images/map-malaysia.jpg and http://maps.google.co.uk/maps.

Wastewater treatment component
Type III: Other project activities
Category III.H: Methane recovery in wastewater treatment (Version 16)
Sectoral Scope 13: Waste Handling and Disposal

Heat generation component
Type I: Renewable energy projects
Category I.C: Thermal energy production with or without electricity (Version 19)
Sectoral scope 1: Energy industries (renewable sources)

Technology to be employed by the Project

The POME from the UOP palm oil mil is currently treated by an open lagoon system. Under the project activity, the POME will be treated in a closed tank anaerobic digester system with biogas recovery before entering the existing lagoon system. An Appropriate + Complete Stirred Tank Reactor (A+CSTR), coupled with an Appropriate + Upflow Sludge Blanket reactor (A+UASB), an anaerobic digester system which was developed by Organics-Natural Power, is planned to be installed. The design volume of the A+CSTR reactor is 4,000m^3 and that of the A+UASB is 200 m^3, allowing a maximum load of 600m^3 wastewater per day. The COD content in the wastewater will be degraded by approximately 95% of which 75% to 80% will be converted to biogas. Biogas generated will be collected at the top of the digester which is covered with a plastic sheet system.

The collected biogas will be delivered to the biogas burner, where the biogas will be used for heat generation and sold to NTPM. Prior to the project activity, NTPM's heat requirements were met by natural gas. It is expected that all biogas produced will be fed to NTPM, since the required natural gas usage level of NTPM far exceeds what the Project can provide.

The heat generation system consists of a gas burner for biogas combustion, and a boiler to generate the steam. The following table shows the technical specification of the heat generation system:

Table 1: Specification of the heat generation system

Burner		**Boiler**	
Type	Gas-fired burner	Type	Fire Tube Package Boiler
Model	Baltur GI 510SPGN	Serial Number	AMC/B-0013/95
Maximum output	6500 kW	Capacity	Saturated Steam at 8000 kg/hour
		Steam Pressure	145 psig
		Thermal efficiency	85% (design efficiency)

An enclosed flare, which is provided by Organics, will be installed for emergency purpose.

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

Years	Estimation of annual emission reductions in tonnes of CO_2e

[4] Appendix B "*Indicative Simplified Baseline and Monitoring Methodologies for Selected Small-scale CDM Project Activity Categories*": http://cdm.unfccc.int/Projects/pac/ssclistmeth.pdf

1 (2013)	39,068
2 (2014)	39,068
3 (2015)	39,068
4 (2016)	39,068
5 (2017)	39,068
6 (2018)	39,068
7 (2019)	39,068
Total estimated reductions (tonnes of CO_2e)	273,476
Total number of crediting years	7
Annual average of the estimated reductions over the crediting period (tonnes of CO_2e)	39,068

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

The Project does not involve funding from an Annex I country.

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

According to Appendix C[5] to the "*Simplified Modalities and Procedures for Small-Scale CDM Project Activities*", a proposed small-scale project activity shall be deemed to be a debundled component of a large project activity if there is a registered small-scale CDM project activity or an application to register another small-scale CDM project activity:

(a) With the same project participants;
(b) In the same project category and technology/measure;
(c) Registered within the previous two years;
(d) Whose project boundary is within 1 km of the project boundary of the proposed small-scale activity under the CDM at the closest point

The project activity is not a debundled component of a larger project activity since there is no other small-scale project activity fulfils the aforementioned criteria.

[5] Appendix C *"Determining the Occurrence of Debundling"*: http://cdm.unfccc.int/EB/007/eb7ra07.pdf

SECTION B. Application of a baseline and monitoring methodology

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

The approved baseline and monitoring methodologies applied to the project activity are:

- AMS-III.H *"Methane recovery in wastewater treatment"*, version 16
- AMS-I.C *"Thermal energy production with or without electricity"*, version 19

The tools referenced in the above methodologies include:

- *"Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion"*, version 02
- *"Emissions from solid waste disposal sites",* version 06.0.0
- *"Tool to calculate baseline, project and/or leakage emissions from electricity consumption"*, version 01
- *"Tool to determine project emissions from flaring gases containing methane"*, version 01
- *"Tool to determine the baseline efficiency of thermal or electric energy generation systems"*, version 01

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

The Project meets all the applicability conditions of the methodologies as described below.

Table 2: Applicability conditions for AMS-III.H version 16

Applicability condition		Project case
1	*This methodology comprises measures that recover biogas from biogenic organic matter in wastewaters by means of one, or a combination, of the following options:* *(f) Introduction of a sequential stage of wastewater treatment with biogas recovery and combustion, with or without sludge treatment, to an anaerobic wastewater treatment system without biogas recovery (e.g. introduction of treatment in an anaerobic reactor with biogas recovery as a sequential treatment step for the wastewater that is presently being treated in an anaerobic lagoon without methane recovery).*	The project activity involves the installation of a sequential stage of wastewater treatment with methane recovery and combustion at an existing open lagoon system with no methane recovery.
2	*In cases where baseline system is anaerobic lagoon the methodology is applicable if:* *(a) The lagoons are ponds with a depth greater than two meters, without aeration. The value for depth is obtained from engineering design documents, or through direct*	The baseline scenario of the project activity involves an open anaerobic lagoon system: (a) The lagoons are ponds with a depth greater than 2 meters, without aeration; (b) On a monthly average basis, the ambient temperature is above 15°C, with daily

	measurement, or by dividing the surface area by the total volume. If the lagoon filling level varies seasonally, the average of the highest and lowest levels may be taken; *(b) Ambient temperature above 15°C, at least during part of the year, on a monthly average basis;* *(c) The minimum interval between two consecutive sludge removal events shall be 30 days.*	minimum mean temperature above 23°C throughout the year[6]; (c) The sludge was removed less than once every 30 days.
3	*The recovered biogas from the above measures may also be utilised for the following applications instead of combustion/flaring:* *(a) Thermal or mechanical, electrical energy generation directly; or ...*	The Project involves the use of the recovered biogas (methane) as fuel for heat production (thermal energy) for export to the paper mill.
4	*If the recovered methane is used for project activities covered under paragraph 2 (a), that component of the project activity can use a corresponding category under type I.*	The approved baseline and monitoring methodology AMS-I.C. is used for the heat generation component of the project activity.
5	*For project activities covered under paragraph 3 (b), if bottles with upgraded biogas are sold outside the project boundary, the end-use of the biogas shall be ensured via a contract between the bottled biogas vendor and the end-user. No emission reductions may be claimed from the displacement of fuels from the end use of bottled biogas in such situations. If however the end use of the bottled biogas is included in the project boundary and is monitored during the crediting period CO_2 emissions avoided by the displacement of fossil fuel can be claimed under the corresponding Type I methodology, e.g. AMS-I.C .Thermal energy production with or without electricity.*	Not applicable. The Project does not involve activities described in paragraph 3(b).
6	*For project activities covered under paragraph 3 (c) (i), emission reductions from the displacement of the use of natural gas are eligible under this methodology, provided the geographical extent of the natural gas distribution grid is within the host country boundaries.*	Not applicable. The Project does not involve activities described in paragraph 3 (c) (i).
7	*For project activities covered under paragraph 3 (c) (ii), emission reductions for the displacement of the use of fuels can be claimed following the provision in the corresponding*	Not applicable. The Project does not involve activities described in paragraph 3 (c) (ii).

[6] Sourced from World Weather Information Service of the World Meteorological Organization for Penang, Malaysia: http://www.worldweather.org/020/c00089.htm (last accessed in Feb 2011).

	Type I methodology, e.g. AMS-I.C.	
8	*In particular, for the case of 3 (b) and (c) (iii), the physical leakage during storage and transportation of upgraded biogas, as well as the emissions from fossil fuel consumed by vehicles for transporting biogas shall be considered. Relevant procedures in paragraph 11 of Annex 1 of AMS-III.H "Methane recovery in wastewater treatment" shall be followed in this regard.*	Not applicable. The Project does not involve activities described in paragraph 3 (b) and (c) (iii).
9	*For project activities covered under paragraph 3 (b) and (c), this methodology is applicable if the upgraded methane content of the biogas is in accordance with relevant national regulations (where these exist) or, in the absence of national regulations, a minimum of 96% (by volume).*	Not applicable. The Project does not involve activities described in paragraph 3 (b) and (c).
10	*If the recovered biogas is utilized for the production of hydrogen (project activities covered under paragraph 3 (d)), that component of the project activity shall use the corresponding methodology AMS-III.O "Hydrogen production using methane extracted from biogas".*	Not applicable. The Project does not involve activities described in paragraph 3 (d).
11	*If the recovered biogas is used for project activities covered under paragraph 3 (e), that component of the project activity shall use corresponding methodology AMS-III.AQ "Introduction of Bio-CNG in road transportation".*	Not applicable. The Project does not involve activities described in paragraph 3 (e).
12	*New facilities (Greenfield projects) and project activities involving a change of equipment resulting in a capacity addition of the wastewater or sludge treatment system compared to the designed capacity of the baseline treatment system are only eligible to apply this methodology if they comply with the relevant requirements in the "General guidelines to SSC CDM methodologies". In addition the requirements for demonstrating the remaining lifetime of the equipment replaced, as described in the general guidelines shall be followed.*	Not applicable. The project activity is not a Greenfield project and does not involve a change of equipment resulting in a capacity addition of the wastewater or sludge treatment system.
13	*The location of the wastewater treatment plant as well as the source generating the wastewater shall be uniquely defined and described in the PDD.*	The location of the wastewater treatment plant as well as the source generating the wastewater is uniquely defined and described in the PDD, Section A.4.1.
14	*Measures are limited to those that result in aggregate emissions reductions of less than or equal to 60 kt CO_2 equivalent annually from all Type III components of the project activity.*	Annual emission reductions (ex-ante) are 31,937 tCO_2e, which is lower than the 60,000 tCO_2e.

Table 3: Applicability conditions for AMS-I.C version 19

Applicability condition		Project case
1	*This methodology comprises renewable energy technologies that supply users with thermal energy that displaces fossil fuel use. These units include technologies such as solar thermal water heaters and dryers, solar cookers, energy derived from renewable biomass and other technologies that provide thermal energy that displaces fossil fuel.*	An anaerobic digester will be installed and biogas from wastewater will be exported to the gas burner for generation of thermal energy, which displaces the use of natural gas at the paper mill.
2	*Biomass-based cogeneration systems are included in this category. For the purpose of this methodology "cogeneration" shall mean the simultaneous generation of thermal energy and electrical energy in one process. Project activities that produce heat and power in separate element processes (for example, heat from a boiler and electricity from a biogas engine) do not fit under the definition of cogeneration project.*	Not applicable. The project activity does not involve cogeneration systems.
3	*Emission reductions from a biomass cogeneration system can accrue from one of the following activities:* *(a) Electricity supply to a grid;* *(b) Electricity and/or thermal energy (steam or heat) production for on-site consumption or for consumption by other facilities;* *(c) Combination of (a) and (b)*	Not applicable. The project activity does not involve cogeneration systems.
4	*The total installed/rated thermal energy generation capacity of the project equipment is equal to or less than 45 MW thermal (see paragraph 6 for the applicable limits for cogeneration project activities).*	The total rated thermal energy generation capacity of the Project is 6.5MW thermal, which is less than 45MW thermal.
5	*For co-fired systems, the total installed thermal energy generation capacity of the project equipment, when using both fossil and renewable fuel shall not exceed 45 MW thermal (see paragraph 6 for the applicable limits for cogeneration project activities).*	The total installed thermal energy generation capacity of the co-fired system is 6.5MW thermal, which does not exceed 45MW thermal.
6	*The following capacity limits apply for biomass cogeneration units:* *(a) If the project activity includes emission reductions from both the thermal and electrical energy components, the total installed energy generation capacity (thermal and electrical) of the project equipment shall not exceed 45 MW thermal.*	Not applicable. The project activity does not involve cogeneration systems.

	For the purpose of calculating this capacity limit the conversion factor of 1:3 shall be used for converting electrical energy to thermal energy (i.e. for renewable energy project activities, the maximal limit of 15 MW(e) is equivalent to 45 MW thermal output of the equipment or the plant); *(b) If the emission reductions of the cogeneration project activity are solely on account of thermal energy production (i.e. no emission reductions accrue from electricity component), the total installed thermal energy production capacity of the project equipment of the cogeneration unit shall not exceed 45 MW thermal;* *(c) If the emission reductions of the cogeneration project activity are solely on account of electrical energy production (i.e. no emission reductions accrue from thermal energy component), the total installed electrical energy generation capacity of the project equipment of the cogeneration unit shall not exceed 15 MW.*	
7	*The capacity limits specified in the above paragraphs apply to both new facilities and retrofit projects. In the case of project activities that involve the addition of renewable energy units at an existing renewable energy facility, the total capacity of the units added by the project should comply with capacity limits in paragraphs 4 to 6, and should be physically distinct from the existing units.*	The rated capacity of the gas burner is less than 45MW, and there is no existing renewable energy facility prior to the Project.
8	*Project activities that seek to retrofit or modify an existing facility for renewable energy generation are included in this category.*	Not applicable. The project activity does not involve retrofit or modification of an existing facility. A new gas burner will be installed for renewable energy generation. The new burner is external to the boiler, thus installation of a new burner will not constitute a retrofit of the existing boiler.
9	*New Facilities (Greenfield projects) and project activities involving capacity additions compared to the baseline scenario are only eligible if they comply with the related and relevant requirements in the "General Guidelines to SSC CDM methodologies".*	Not applicable. The project activity is not a Greenfield project and does not involve capacity additions.
10	*If solid biomass fuel (e.g. briquette) is used, it shall be demonstrated that it has been produced*	Not applicable. No solid biomass fuel is used in the Project.

	using solely renewable biomass and all project or leakage emissions associated with its production shall be taken into account in emissions reduction calculation.	
11	*Where the project participant is not the producer of the processed solid biomass fuel, the project participant and the producer are bound by a contract that shall enable the project participant to monitor the source of the renewable biomass to account for any emissions associated with solid biomass fuel production. Such a contract shall also ensure that there is no double-counting of emission reductions.*	Not applicable. No solid biomass fuel is used in the Project.
12	*If electricity and/or steam/heat produced by the project activity is delivered to a third party i.e. another facility or facilities within the project boundary, a contract between the supplier and consumer(s) of the energy will have to be entered into that ensures there is no double-counting of emission reductions.*	The heat produced by the project activity will be delivered to the NTPM, and in case NTPM does not take the gas/heat, to UOP. Contracts between the supplier (Magenko) and consumers of the energy (NTPM and UOP) have been entered into specifying that there is no double-counting of emission reductions.
13	*If the project activity recovers and utilizes biogas for power/heat production and applies this methodology on a stand alone basis i.e. without using a Type III component of a SSC methodology, any incremental emissions occurring due to the implementation of the project activity (e.g. physical leakage of the anaerobic digester, emissions due to inefficiency of the flaring), shall be taken into account either as project or leakage emissions.*	Not applicable. Type III component of a SSC methodology and methodology AMS.III-H are used in the Project.
14	*Charcoal based biomass energy generation project activities are eligible to apply the methodology only if the charcoal is produced from renewable biomass sources5 provided:* *(a) Charcoal is produced in kilns equipped with methane recovery and destruction facility; or* *(b) If charcoal is produced in kilns not equipped with a methane recovery and destruction facility, methane emissions from the production of charcoal shall be considered. These emissions shall be calculated as per the procedures defined in the approved methodology AMS-III.K. Alternatively, conservative emission factor values from peer reviewed literature or from a registered CDM project activity can be used, provided that it can be*	Not applicable. The Project does not involve charcoal based biomass energy generation.

	demonstrated that the parameters from these are comparable e.g. source of biomass, characteristics of biomass such as moisture, carbon content, type of kiln, operating conditions such as ambient temperature.	

B.3. Description of the project boundary:

In accordance with the methodologies AMS-III.H and AMS-I.C, the project boundary is described as follow:

Project boundary for AMS-III.H
"The project boundary is the physical, geographical site where the wastewater and sludge treatment takes place, in the baseline and project situations. It covers all facilities affected by the project activity including sites where processing, transportation and application or disposal of waste products as well as biogas takes place."

Project boundary for AMS-I.C
"The spatial extent of the project boundary encompasses:

(a) All plants generating power and/or heat located at the project site, whether fired with biomass, fossil fuels or a combination of both;
(b) All power plants connected physically to the electricity system (grid) that the project plant is connected to;
(c) Industrial, commercial or residential facility, or facilities, consuming energy generated by the system and the processes or equipment affected by the project activity;
(d) The processing plant of biomass residues, for project activities using solid biomass fuel (e.g. briquette), unless all associated emissions are accounted for as leakage emissions;
(e) The transportation itineraries, if the biomass is transported over distances greater than 200 kilometres, unless all associated emissions are accounted for as leakage emissions;
(f) The site of the anaerobic digester in the case of project activity that recovers and utilizes biogas for power/heat production and applies this methodology on a stand alone basis i.e. without using a Type III component of a SSC methodology."

The baseline and project boundaries are illustrated in the diagrams below.

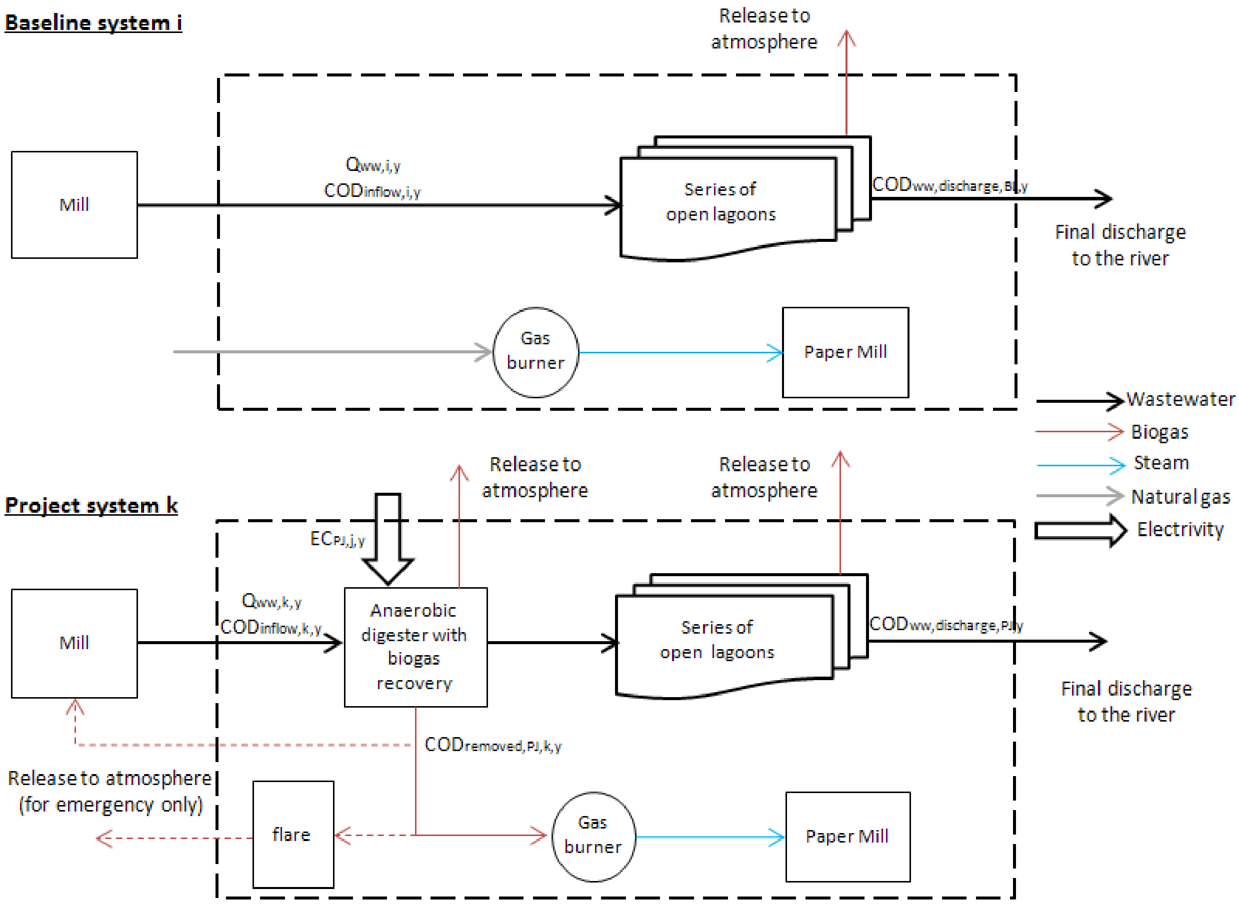


Figure 2: The baseline and project boundaries

The emission sources and gases which are included in the project boundary for the purpose of calculating project emissions and baseline emissions are listed below:

Baseline emissions

1. CO_2 emissions from the consumption of fossil fuel (natural gas) for steam production at the paper mill.
2. Methane emissions from the baseline wastewater treatment system.
3. Methane emissions on account of inefficiencies in the baseline wastewater treatment systems and presence of degradable organic carbon in the treated wastewater discharged into river.

Project emissions

1. CO_2 emissions from the electivity consumption for the newly installed wastewater treatment system (anaerobic digester).
2. Methane emissions from wastewater treatment systems affected by the project activity, and not equipped with biogas recovery in the project scenario.
3. Methane emissions on account of inefficiency of the project activity wastewater treatment systems and presence of degradable organic carbon in treated wastewater.
4. Methane fugitive emissions due to inefficiencies in capture systems.
5. Methane emissions due to incomplete flaring (for emergency only).

B.4. Description of baseline and its development:

Wastewater treatment component

Prior to the implementation of the Project, wastewater from the mill is treated in a series of open lagoons, consisting of 8 ponds. Under the Project, wastewater will be treated in the newly installed anaerobic digester with biogas recovery, followed by the existing open lagoons. This is described as per AMS-III.H (version 16) 1(f):

"Introduction of a sequential stage of wastewater treatment with biogas recovery and combustion, with or without sludge treatment, to an anaerobic wastewater treatment system without biogas recovery"

Heat generation component

The baseline scenario as described in AMS-I.C (version 19) is as follow:

"For renewable energy that displaces technologies using fossil fuels, the simplified baseline is the fuel consumption of the technologies that would have been used in the absence of the project activity times an emission factor for the fossil fuel displaced."

The Project produces and captures biogas from the wastewater treatment system which will be exported to the gas burner to generate heat for the paper mill. In the absence of the project activity, natural gas would have been used for the thermal energy generation.

B.5. Description of how the anthropogenic emissions of GHG by sources are reduced below those that would have occurred in the absence of the registered small-scale CDM project activity:

According to the Attachment A to Appendix B of the *"Simplified Modalities and Procedures for Small-Scale CDM Project Activities"*, the project participants shall demonstrate the project activity is additional, i.e. the project activity would not have occurred anyway, due to at least one of the following barriers:

- Investment barrier;
- Technological barrier;
- Barrier due to prevailing practice; and
- Other barriers.

Investment barrier

To demonstrate additionality, an investment analysis is carried out to determine whether the Project is financial feasible without the sale of certificated emission reductions (CERs).

In accordance with EB35, Annex 34 *"Non-binding best practice examples to demonstrate additionality for SSC project activities"*[7], the best practice examples for investment barrier include the application of investment comparison analysis using a relevant financial indicator, application of a benchmark analysis or simple cost analysis. The benchmark analysis is used since CDM is not the only revenue for the Project,

[7]UNFCCC: EB35, Annex 34. http://cdm.unfccc.int/EB/035/eb35_repan34.pdf

biogas/ heat will be sold to NTPM. This choice is consistent with EB51, Annex 58 *"Guidance on the Assessment of Investment Analysis (Version 05)"*[8].

The project internal rate of return (IRR) is considered as an appropriate financial indicator for the investment analysis of the Project. As per the *"Guidance on the Assessment of Investment Analysis"*, benchmark supplied by relevant national authorities are appropriate.

An article, *"Renewable Energy: The Failure of the Malaysian 5th Fuel Policy"*, was published in Jurutera Magazine in July 2006. Jurutera Magazine is a publication of The Institution of Engineers Malaysia (IEM). According to the article, a research survey on the investment potential of the renewable energy plants was carried out and part of the results are summarized below:

Table 4: Comparison of responses of the various respondents

	Bankers	Palm Oil Millers	Renewable Energy Developers
Project IRR (%)	15 -18%	15 - 18%	12 - 15%
Loan Tenure (years)	>10 years	10 -15 years	10 -15 years

As can be seen the table above, industry players other than the renewable energy developers required a higher return with project IRR not less than 15%, which is mainly to lessen the risks and uncertainties of the type of projects that they are not familiar with. Renewable Energy Developers are willing to accept a lower return and they are comfortable with project IRR not less than 12%[9].

In the course of the Validation, a question was raised by the DOE as to whether the benchmark published in 2006 remains valid in 2011 at the time of decision making. A benchmark is composed of the cost of financing plus various risk premiums such as foreign exchange risks and risk for using new technologies.

In the first half of 2006, the Base Lending Rate (BLR) of commercial banks in Malaysia averaged 6.51%, as shown below:

Table 5: Base Lending Rate of commerical banks in Malaysia[10]

	Jan – 2006	Feb - 2006	Mar - 2006	Apr - 2006	May - 2006	Jun - 2006
BLR (%)	6.21	6.34	6.47	6.58	6.72	6.72

The investment decision was finalized on the date of signing the Investment agreement and Sales contract on the 01/06/2011. The BLR of commercial banks in Malaysia in the first half of 2011 is as follow:

Table 6: Base Lending Rate of commerical banks in Malaysia[11]

	Jan – 2011	Feb - 2011	Mar - 2011	Apr - 2011	May - 2011	Jun - 2011
BLR (%)	6.27	6.27	6.27	6.27	6.54	6.54

[8] UNFCCC: http://cdm.unfccc.int/Reference/Guidclarif/reg/reg_guid03.pdf

[9] Since the article did not specific whether the project IRR is pre-tax or post-tax, for conservativeness, the chosen 12% benchmark is assumed to be a pre-tax benchmark.

[10] Central Bank of Malaysia, Monthly Statistical Bulletin June 2006, V.1 Interest Rates: Banking Institutions http://www.bnm.gov.my/files/publication/msb/2006/6/pdf/v_01.pdf

[11] Central Bank of Malaysia, Monthly Statistical Bulletin June 2011, 2.1 Interest Rates: Banking Institutions http://www.bnm.gov.my/files/publication/msb/2011/6/xls/2.1.xls

The BLR at the time of decision making is 6.54%, which is almost the same as the BLR at the time the report in question was published. Given that the risk premiums do not fluctuate significantly over time, it can be said that the benchmark reported in 2006 was still valid at the time of decision making. Therefore, it is considered to be appropriate to choose 12% as the benchmark for the Project.

Project IRR calculation

The parameters required for pre-tax IRR calculation are summarized in Table 7. It is noted that the input values were valid and applicable at the time of decision making and will be explained and/ or submitted to the DOE.

Table 7: Basic parameters for investment analysis

Input parameter		Value	Unit	Notes
Project lifetime		14	years	-
Project cost		2,754,785	EUR	-
O&M Cost		118,000	EUR/y	
Other running costs	To UOP (as a portion of Gas revenue)	9,858	EUR/y	These costs include use of UOP's land to construct and operate the Project facility, and the right to use the POME "raw material".
Depreciation	Depreciation rate	7%	-	Flat rate Depreciation
	Depreciation period	14	year	Project lifetime
	Salvage value	0	-	At the end of the project life, Magenko will give all the equipments to UOP for free
Revenue	Expected CH_4 export amount to papermill	120,490	mmBtu/y	Calculated[1)]
	Natural gas price	3.41	EUR/mmBtu	NTPM invoice dated March 2011, consistent with published natural gas tariff in Malaysia
	Biogas/heat sales price	2.73	EUR/mmBtu	80% of Gas sales price in Malaysia
CERs	CER amount	39,068	tCO_2/yr	Calculated
	CER unit price	10	EUR/tCO_2	-

[1)] A digester efficiency of 90% was used for calculating the amount of biogas produced from the digester, it is considered to be reasonably conservative.

Based on the input data in Table 7, the IRR of the Project without the revenue of CDM is calculated to be 0.27%, which is below the IRR benchmark. The Project is considered as financially attractive only if its IRR is above or equal to the corresponding financial benchmark. With the assistance of CDM, the IRR becomes 17.76%, and thus it can be concluded that the Project is financially feasible with the revenue from the sales of CERs.

Sensitivity analysis

In order to verify whether the conclusion regarding the financial/economic attractiveness is robust to reasonable variations in the critical assumptions, a sensitivity analysis was performed. The major financial parameters of the Project are capital cost, O&M cost, biogas/heat price and biogas quantity, these parameters with variations covering a range of 10% and – 10% were used in the analysis. It is noted that only the variations which would result in a more favorable IRR were summarized in the table below:

Table 8: Results of sensitivity analysis of the Project (without CDM)

Sensitivity test	Variation	IRR
Base	-	0.27%
Capital cost	-10%	1.72%
O&M costs	-10%	1.05%
Biogas/heat price	10%	2.38%
Biogas quantity	10%	2.38%

As can be seen, the IRRs remain below the benchmark after variations on the chosen financial parameters. The sensitivity analysis thus confirmed that the Project is financially unattractive.

Apart from the above parameters, a fifth sensitivity analysis of the grid connection scenario was also included for the possibility of selling the power generated from captured biogas to the national grid[12]. The installed capacity for power generation is expected to be 2.0MW. The parameters required for pre-tax IRR calculation are summarized in Table 9. It is transparently noted that this particular alternative only came to be discussed by the Project Participant many months after the initial decision making date, as this alternative only became remotely feasible with the introduction of the new, higher grid tariff. While the CDM rules suggest that the investment analysis shall use information available at the time of decision making, and the investment analysis as summarized in Table 7 has indeed used such input values, the input values in Table 9 were valid at the time when the grid connection alternative became a real plausible option to the Project Participants, in early- to mid-2012.

Table 9: Basic parameters for investment analysis (Grid connection)

Input parameter		Value	Unit	Notes
Project lifetime		14	years	-
Project cost		4,552,060	EUR	Organics Proposal dated February 2012.
O&M Cost		478,455	EUR/y	Organics Proposal dated February 2012.
Other running costs	To UOP (as a portion of Gas revenue)	31,657	EUR/y	These costs include use of UOP's land to construct and operate the Project facility, and the right to use the POME "raw material".
Depreciation	Depreciation rate	7%	-	Flat rate Depreciation
Depreciation	Depreciation period	14	year	Project lifetime
Depreciation	Salvage value	0	-	At the end of the project life, Magenko will give all the equipments to UOP for free
Revenue	Expected electricity export to the Grid	13,656	MWh/y	Calculated.
Revenue	Electricity tariff	80.0	EUR/MWh	FiT rate for biogas[13]

[12]At the time of verification, if the grid connection scenario occurs to replace selling of biogas to NTPM, a request for project plan change in relation to the change in methodology will be submitted. This is in line with SSC_559.

[13] Sustainable Energy Development Authority Malaysia (SEDA), 2012 FiT rates for installed capacity ≤ 4MW and use of gas engines technology with electrical efficiency of above 40% (http://seda.gov.my/). This is the highest tariff assumption possible at the time of this assessment. It is noted that at the time of the original decision making date, the tariff was 0.21MYR/kWh, equivalent to 47.7 EUR/MWh.

Based on the input data in Table 9, the IRR of the grid connection scenario is calculated to be 8.18%, which is below the IRR benchmark[14]. Thus, it can be concluded that the Project is financially infeasible even with the revenue from the sales of electricity to the grid.

To ensure the robustness of the sensitivity test, the variation of the major financial parameters when the Project IRR reaches the benchmark was also examined as in the table below.

Table 10: Variation of financial parameters with Project IRR of 12% (without CDM)

Sensitivity test	Variation of the parameter to make the IRR reach 12%	Value
Capital cost	-51.70%	1,330,561 EUR
O&M costs	-182.00%	- 96,760EUR (This is unrealistic)
Biogas/heat price	65.40%	4.52 EUR/mmBtu
Biogas quantity	65.40%	199,291 mmBtu

The above variations are unlikely to happen, justifications as below:

Capital cost

It is unrealistic that the capital cost will decrease by 51.70%. The input capital cost in the IRR calculation was based on the proposals from the technology suppliers, which is unlikely to reduce the price by more than 50%. In addition, the inflation rate in Malaysia was at 3.3% in August 2011, and the average inflation rate was 2.77% from 2005 to 2011[15]. It is more likely to increase the capital cost, rather than decrease.

O&M costs

As can be seen in Table 10, the O&M costs have the least impact on the Project IRR comparing to other chosen financial parameters. The Project IRR will not reach the benchmark even the Project does not take any O&M costs into account, thus, it is impossible for the Project IRR to reach the benchmark by varying the O&M costs.

Biogas/ heat price

The biogas/ heat price moves with the natural gas price. According to the Gas Malaysia Sdn. Bhd. annual reports[16], the price of the natural gas has adjusted 3 times over the last decade. In the last decade to 2011, there was a 17.4% decrease of natural gas price. Thus, increasing the biogas price by > 60% is not likely.

Biogas quantity

The biogas generated from the anaerobic digester was estimated based on the FFB processing amount and the inlet COD. The expected FFB processing amount was calculated from the capacity of the Mill, and

[14] It is furthermore noted that for absolute transparency, a sensitivity analysis was carried out on the grid connection scenario, despite the fact that at the time of validation, this scenario remained unconfirmed (i.e. a double sensitivity analysis). The results showed that for all variations, the IRR remained below the 12% benchmark. Specifically, a decrease in capital cost resulted in 10.09%; a decrease in O&M cost 9.73%; increase in electricity generation 11.48%.

[15] Trading Economics – Malaysia inflation rate: http://www.tradingeconomics.com/malaysia/inflation-cpi

[16] Gas Malaysia Sdn. Bhd. annual reports: http://www.gasmalaysia.com/inside_GM/annual_rpt.php

processing an additional 60% FFB is not possible. The Inlet COD used for calculation was sourced from the historical data, where there were only ~ +/- 10% differences over the past 18 months, therefore, 65.40% increase is highly improbable.

Prior consideration of the CDM

As per EB62 Annex 13 *"Guidelines on the demonstration and assessment of prior consideration of the CDM (Version 04)"*[17], the project participant of a proposed project activity with a start date on or after 2 August 2008 must inform a Host Party DNA and the UNFCCC secretariat in writing of the commencement of the project activity and of their intention to seek CDM status within six months of the project start date. The starting date of the project activity is on 01/06/2011, which was the date on which the Investment Agreement and Sales Contract were executed between Magenko Penang's parent company Magenko Holdings and the host mill (UOP) and heat offtaker (NTPM), respectively. A prior consideration form has been submitted to the DNA and the UNFCCC on 23/02/2011, well ahead of the project start date.

The following table summarizes the project timeline and all relevant evidence submitted to DOE for validation.

Table 11: Project timeline related to EB49, Annex 22

Date	Key event	Evidence/Remarks
28 July2010	Received Asiatica's final proposal	Proposal excerpt submitted to DOE.
10 August 2010	Executed CDM consultancy agreement with Asiatica	Agreement excerpt submitted to DOE.
24 February 2011	Prior consideration form sent to UNFCCC Secretariat	Recorded on UNFCCC website.
24 February 2011	Prior consideration form sent to Malaysia DNA	Acknowledgment email from Malaysia DNA.
1 June 2011 **[Project Start Date]**	UOP Investment Agreement between Magenko Holding Ltd.and United Oil Palm Industries Sdn. Bhd. and Sales Contract between Magenko Holding Ltd. and Nibong Tebal Paper Mill Sdn. Bhd. with amendment	Agreement excerpt submitted to DOE.

B.6. Emission reductions:

B.6.1. Explanation of methodological choices:

Emissions reductions for the proposed project are calculated based on the methodologies below:

1. AMS-III.H *"Methane recovery in wastewater treatment"*, version 16
2. AMS-I.C *"Thermal energy production with or without electricity"*, version 19

The total annual emission reductions for the proposed project ($ER_{total,y}$) are estimated ex-ante as the combination of the emission reductions from the wastewater treatment component (ER_y), and the heat generation component ($ER_{thermal,y}$).

[17] UNFCCC: EB62 Annex 13. http://cdm.unfccc.int/Reference/Guidclarif/reg/reg_guid04.pdf

$$ER_{total,y} = ER_y + ER_{thermal,y}$$

1. Wastewater treatment component

As per AMS-III.H, emission reductions shall be estimated ex-ante as follows:

$$ER_{y,ex\ ante} = BE_{y,ex\ ante} - \left(PE_{y,ex\ ante} + LE_{y,ex\ ante}\right)$$

Where:

$ER_{y,ex\text{-}ante}$	*Ex- ante emission reduction in year y (tCO_2e).*
$BE_{y,ex\text{-}ante}$	*Ex-ante leakage emissions in year y (tCO_2e).*
$PE_{y,ex\text{-}ante}$	*Ex-ante project emissions in year y (tCO_2e).*
$LE_{y,ex\text{-}ante}$	*Ex-ante baseline emissions in year y (tCO_2e).*

For ex-post calculation, emission reductions achieved in any year are the lowest value of the following:

$$ER_{y,ex-post} = min\left(\left(BE_{y,ex-post} - PE_{y,ex-post} - LE_{y,ex-post}\right), \left(MD_y - PE_{power,y} - PE_{biomass,y} - LE_{y,ex-post}\right)\right)$$

Where:

$ER_{y,ex\ \text{-}post}$	*Emission reductions achieved by the project activity based on monitored values for year y (tCO_2e)*
$BE_{y,ex\text{-}post}$	*Baseline emissions calculated as per paragraph 18 using ex post monitored values*
$PE_{y,ex\text{-}\ post}$	*Project emissions calculated as per paragraph 29 using ex post monitored values*
MD_y	*Methane captured and destroyed/gainfully used by the project activity in the year y (tCO_2e)*

1.1 Baseline emissions (BE_y)

The baseline emissions for the system affected by the project activity are expressed as:

$$BE_y = BE_{power,y} + BE_{ww,treatment,y} + BE_{s,treatment,y} + BE_{ww,discharge,y} + BE_{s,final,y}$$

Where:

BE_y	*Baseline emission in year y (tCO_2e).*
$BE_{power,y}$	*Baseline emissions from electricity or fuel consumption in year y (tCO_2e).*
$BE_{ww,treatment,y}$	*Baseline emissions of the wastewater treatment systems affected by the project activity in year y (tCO_2e).*
$BE_{s,treatment,y}$	*Baseline emissions of the sludge treatment systems affected by the project activity in year y (tCO_2e).*
$BE_{ww,discharge,y}$	*Baseline methane emissions from degradable organic carbon in treated wastewater discharged into sea/ river/ lake in year y (tCO_2e).*
$BE_{s,final,y}$	*Baseline methane emissions from anaerobic decay of the final sludge produced in year y (tCO_2e).*

1.1.1 Baseline emissions from electricity or fuel consumption in year y ($BE_{power,y}$)

In the baseline scenario, the electricity consumed for the wastewater treatment system is negligible, this term shall be neglected.

1.1.2 Baseline emissions of the wastewater treatment systems affected by the project activity in year y ($BE_{ww,treatment,y}$)

The methane emissions from the baseline wastewater treatment systems affected by the project are determined using the COD removal efficiency of the baseline plant:

$$BE_{ww,treatment,y} = \sum_i \left(Q_{ww,i,y} \times COD_{inflow,i,y} \times \eta_{COD,BL,i} \times MCF_{ww,treatment,BL,i}\right) \times B_{o,ww} \times UF_{BL} \times GWP_{CH4}$$

Where:

$Q_{ww,i,y}$	*Volume of wastewater treated in baseline wastewater treatment system i in year y (m^3).*
$COD_{inflow,i,y}$	*Chemical oxygen demand of the wastewater inflow to the baseline treatment system i in year y (t/m^3).*
$\eta_{COD,BL,i}$	*COD removal efficiency of the baseline treatment system i.*
$MCF_{ww,treatment,BL,i}$	*Methane correction factor for baseline wastewater treatment systems i.*
$B_{o,ww}$	*Methane producing capacity of the wastewater ($kgCH_4/kgCOD$).*
UF_{BL}	*Model correction factor to account for model uncertainties.*
GWP_{CH4}	*Global Warming Potential for methane (tCO_2/tCH_4).*

1.1.3 Baseline emissions of the sludge treatment systems affected by the project activity in year y ($BE_{s,treatment,y}$)

Since there is no involvement of sludge treatment in the baseline scenario, this term is not taken into account in the baseline emission calculations.

1.1.4 Baseline methane emissions from degradable organic carbon in treated wastewater discharged into sea/ river/ lake in year y ($BE_{ww,discharge,y}$)

According to *"Biogas from POME Preliminary Data Questionnaire"*, treated wastewater is discharged into river, the baseline methane emissions are calculated using equation below:

$$BE_{ww,,discharge,y} = Q_{ww,y} \times GWP_{CH4} \times B_{o,ww} \times UF_{BL} \times COD_{ww,discharge,BL,y} \times MCF_{ww,BL,discharge}$$

Where:

$Q_{ww,y}$	*Volume of treated wastewater discharged in year y(m^3).*
$COD_{ww,discharge,BL,y}$	*Chemical oxygen demand of the treated wastewater discharged into sea, river or lake in the baseline situation in the year y (t/m^3).*
$MCF_{ww, BL, discharge}$	*Methane correction factor based on discharge pathway or system in the baseline situation (e.g. into sea, river or lake) of the wastewater*

1.1.5 Baseline methane emissions from anaerobic decay of the final sludge produced in year y ($BE_{s,final,y}$)

The sludge is given away to farmers for land application in the baseline scenario, as per AMS-III.H, this term shall be neglected.

1.2 Project activity emissions (PE_y)

The project activity emissions from the system affected by the project activity are expressed as:

$$PE_y = \left\{ \begin{matrix} PE_{power,y} + PE_{ww,treatment,y} + PE_{s,treatment,y} + PE_{ww,discharge,y} + PE_{s,final,y} \\ +PE_{fugitive,y} + PE_{biomass,y} + PE_{flaring,y} \end{matrix} \right\}$$

Where:

PE_y	*Project activity emissions in the year y (tCO_2e).*
$PE_{power,y}$	*Emissions from electricity or fuel consumption in the year y (tCO_2e).*
$PE_{ww,treatment,y}$	*Methane emissions from wastewater treatment systems affected by the project activity, and not equipped with biogas recovery, in year y (tCO_2e).*
$PE_{s,treatment,y}$	*Methane emissions from sludge treatment systems affected by the project activity, and not equipped with biogas recovery, in year y (tCO_2e).*
$PE_{ww,discharge,y}$	*Methane emissions from degradable organic carbon in treated wastewater in year y (tCO_2e).*
$PE_{s,final,y}$	*Methane emissions from anaerobic decay of the final sludge produced in year y (tCO_2e).*
$PE_{fugitive,y}$	*Methane emissions from biogas release in capture systems in year y (tCO_2e).*
$PE_{flaring,y}$	*Methane emissions due to incomplete flaring in year y (tCO_2e).*
$PE_{biomass,y}$	*Methane emissions from biomass stored under anaerobic conditions (tCO_2e).*

1.2.1 Emissions from electricity or fuel consumption in the year y ($PE_{power,y}$)

As per the procedures described in the *"Tool to calculate baseline, project and/or leakage emissions from electricity consumption"*, the project emission from electricity is

$$PE_{power,y} = \sum_j EC_{PJ,j,y} \times EF_{EL,j,y} \times \left(1 + TDL_{j,y}\right)$$

Where:

$EC_{PJ,j,y}$	*Quantity of electricity consumed by the project electricity consumption source j in year y (kW).*
$EF_{EL,j,y}$	*Emission factor for electricity generation for source j in year y (tCO_2/MWh).*
$TDL_{j,y}$	*Average technical transmission and distribution losses for providing electricity to source j in year y.*

1.2.2 Methane emissions from wastewater treatment systems affected by the project activity, and not equipped with biogas recovery, in year y ($PE_{ww,treatment,y}$)

$$PE_{ww,treatment,y} = \sum_i \left(Q_{ww,k,y} \times COD_{inflow,k,y} \times \eta_{COD,PJ,k} \times MCF_{ww,treatment,PJ,k}\right) \times B_{o,ww} \times UF_{PJ} \times GWP_{CH4}$$

Where:

$Q_{ww,k,y}$	*Volume of wastewater treated in project treatment system k in year y (m^3).*
$COD_{inflow,k,y}$	*Chemical oxygen demand of the wastewater inflow to the project treatment system k in year y (t/m^3).*

$\eta_{COD,PJ,k}$	*Chemical oxygen demand removal efficiency of the project wastewater treatment system k in year y.*
$MCF_{ww,treatment,PJ,k}$	*Methane correction factor for project wastewater treatment systems k.*
UF_{PJ}	*Model correction factor to account for model uncertainties.*

1.2.3 Methane emissions from sludge treatment systems affected by the project activity, and not equipped with biogas recovery, in year y ($PE_{s,treatment,y}$)

The Project does not involve sludge treatment systems, the methane emissions from sludge treatment systems shall be neglected.

1.2.4 Methane emissions from degradable organic carbon in treated wastewater in year y ($PE_{ww,discharge,y}$)

Similar to the baseline scenario, treated wastewater will be discharged into river, the methane emissions for the Project are calculated using the following equation:

$$PE_{ww,discharge,y} = \sum_{i} \left(Q_{ww,y} \times COD_{ww,discharge,PJ,y} \times MCF_{ww,PJ,discharge} \right) \times B_{o,ww} \times UF_{PJ} \times GWP_{CH4}$$

Where:

$Q_{ww,y}$	*Volume of treated wastewater discharged in year y (m^3).*
$COD_{ww,discharge,PJ,y}$	*Chemical oxygen demand of the treated wastewater discharged into the sea, river or lake in the project scenario in year y (t/m^3).*
$MCF_{ww,PJ,discharrge}$	*Methane correction factor based on the discharge pathway of the wastewater in the project scenario (e.g. into sea, river or lake).*

1.2.5 Methane emissions from anaerobic decay of the final sludge produced in year y ($PE_{s,final,y}$)

In the project activity, the final sludge produced will be applied for soil application, as per AMS-III.H, this term shall be neglected.

1.2.6 Methane emissions from biogas release in capture systems in year y ($PE_{fugitive,y}$)

For the two options provided in the methodology AMS-III.H, option (a) *"based on the methane emission potential of wastewater and/or sludge"* was chosen and the calculation is given below.

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

Where:

$PE_{fugitive,ww,y}$	*Fugitive emissions through capture inefficiencies in the anaerobic wastewater treatment systems in the year y (tCO_2e).*
$PE_{fugitive,s,y}$	*Fugitive emissions through capture inefficiencies in the anaerobic sludge treatment systems in the year y y (tCO_2e).*

Since there is no sludge treatment system in the project activity, only the term $PE_{fugitive,ww,y}$ shall be considered for the calculation of methane emissions.

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

Where:

CFE_{ww}	*Capture efficiency of the biogas recovery equipment in the wastewater treatment systems.*
$MEP_{ww,treatment,y}$	*Methane emission potential of wastewater treatment systems equipped with biogas recovery system in year y (t).*

$$MEP_{ww,treatment,y} = Q_{ww,y} \times B_{o,ww} \times UF_{PJ} \times \sum_{k} COD_{removed,PJ,k,y} \times MCF_{ww,treatment,PJ,k}$$

Where:

$COD_{removed,PJ,k,y}$	*The chemical oxygen demand removed by the treatment system k of the project activity equipped with biogas recovery in the year y (t/m^3).*
$MCF_{ww,treatment,PJ,k}$	*Methane correction factor for the project wastewater treatment system k equipped with biogas recovery equipment.*

1.2.7 Methane emissions due to incomplete flaring in year y ($PE_{flaring,y}$)

According to AMS-III.H, for ex-ante estimation, baseline emissions calculation for wastewater treatment (i.e. $BE_{ww,\ treatment,\ y}$) can be used to calculate methane emissions due to incomplete flaring, but without the consideration of GWP for CH_4. However, the ex-post emission reduction shall be calculated as per the "*Tool to determine project emissions from flaring gases containing methane"* by using actual monitored data.

As per the "*Tool to determine project emissions from flaring gases containing methane"*, the Project emissions from flaring are calculated as below:

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

Where:

$PE_{flare,y}$	*Project emissions from flaring of the residual gas stream in year y (tCO$_2$e).*
$TM_{RG,h}$	*Mass flow rate of methane in the residual gas in the hour h (kg/h).*
$\eta_{flare,h}$	*Flare efficiency in hour h.*
GWP_{CH4}	*Global Warming Potential of methane valid for the commitment period (21 tCO$_2$e/tCH$_4$).*

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

Where:

$FV_{RG,h}$	*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 (0.716kg/m^3)*

Hourly flare efficiency for enclosed flares can be determined either by employing default value or by continuous monitoring. In both cases, "*Tool to determine project emissions from flaring gases containing methane"* shall be followed.

1.2.8 Methane emissions from biomass stored under anaerobic conditions ($PE_{biomass,y}$)

There is no biomass storage under anaerobic conditions in the Project, thus this term shall be neglected.

1.3 Leakage (LE_y)

The equipment of the Project is not transferred from another activity, leakage effects are not considered.

2. Heat generation component

As per AMS-I.C, the emission reductions are calculated as follows:

$$ER_{thermal,y} = BE_{thermal,y} - PE_{thermal,y} - LE_{thermal,y}$$

Where:

$ER_{thermal,y}$	*Emission reduction in year y (tCO_2e).*
$BE_{thermal,y}$	*Leakage emissions in year y (tCO_2e).*
$PE_{thermal,y}$	*Project emissions in year y (tCO_2e).*
$LE_{thermal,y}$	*Baseline emissions in year y (tCO_2e).*

2.1 Baseline emissions ($BE_{thermal,y}$)

According to AMS-I.C paragraph 15, the baseline scenario of the project activity is:

"(a) Electricity is imported from the grid and thermal energy (steam/heat) is produced using fossil fuel"

The baseline emissions for steam/heat produced using fossil fuels (natural gas) are calculated as follows:

$$BE_{thermal,CO2,y} = \left(EG_{thermal,y}/\eta_{BL,thermal}\right) \times EF_{FF,CO2}$$

Where:

$BE_{thermal,CO2,y}$	*The baseline emissions from steam/heat displaced by the project activity during the year y (tCO_2)*
$EG_{thermal,y}$	*The net quantity of steam/heat supplied by the project activity during the year y (TJ)*
$EF_{FF,CO2}$	*The CO_2 emission factor of the fossil fuel that would have been used in the baseline plant (tCO_2/TJ)*
$\eta_{BL,thermal}$	*The efficiency of the plant using fossil fuel that would have been used in the absence of the project activity*

2.2 Project emissions ($PE_{thermal,y}$)

After the implementation of the project activity, the fossil fuels (natural gas) will be fully displaced by the biogas captured from the wastewater treatment systems for heat generation. Thus, for ex-ante, the project emissions are zero.

For ex-post, Quantity of fuel combusted ($FC_{i,j,y}$) must be calculated using the *"Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion"*.

2.3 Leakage ($LE_{thermal,y}$)

The energy generating equipment of the Project is not transferred from outside the boundary to the project activity, and the biogas used for heat generation is obtained within the project boundary. Thus, leakage effects are not considered.

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

Data / Parameter:	$COD_{inflow,i,y}$
Data unit:	*Tonnes/m^3*
Description:	*Chemical oxygen demand of the wastewater inflow to the baseline treatment system i in year y*
Source of data used:	*Historical data*
Value applied:	*0.0668794*
Justification of the choice of data or description of measurement methods and procedures actually applied :	*According to AMS-III.H, COD inflow was determined using historical records of at least one year prior to the project implementation.*
Any comment:	-

Data / Parameter:	$COD_{ww,discharge,BL,y}$
Data unit:	*Tonnes/m^3*
Description:	*Chemical oxygen demand of the treated wastewater discharged into sea, river or lake in the baseline situation in the year y*
Source of data used:	*Historical data*
Value applied:	*0.00081539*
Justification of the choice of data or description of measurement methods and procedures actually applied :	*According to AMS-III.H, COD discharged was determined using historical records of at least one year prior to the project implementation.*
Any comment:	-

Data / Parameter:	$MCF_{ww,treatment,BL,i}$
Data unit:	-
Description:	*Methane correction factor for baseline wastewater treatment systems i*
Source of data used:	*Table III.H.1 in AMS-III.H, version 16.*
Value applied:	*0.8*

Justification of the choice of data or description of measurement methods and procedures actually applied :	*The depth of the anaerobic lagoons in the baseline wastewater treatment system is more than 2 meters, therefore MCF value is chosen as 0.8.*
Any comment:	*"2006 IPCC Guidelines for National Greenhouse Gas Inventories" default values (Chapter 6 of Volume 5, Table 6.8).*

Data / Parameter:	$MCF_{ww,discharge,BL}$
Data unit:	-
Description:	*Methane correction factor based on discharge pathway or system in the baseline situation (e.g. into sea, river or lake) of the wastewater.*
Source of data used:	*Table III.H.1 in AMS-III.H, version 16.*
Value applied:	*0.1*
Justification of the choice of data or description of measurement methods and procedures actually applied :	*In the baseline situation, the treated wastewater is discharged into river.*
Any comment:	*"2006 IPCC Guidelines for National Greenhouse Gas Inventories" default values (Chapter 6 of Volume 5, Table 6.8).*

Data / Parameter:	$MCF_{ww,treatment,PJ,k}$
Data unit:	-
Description:	*Methane correction factor for project wastewater treatment systems k*
Source of data used:	*Table III.H.1 in AMS-III.H, version 16.*
Value applied:	*0.8*
Justification of the choice of data or description of measurement methods and procedures actually applied :	*The project wastewater treatment system without biogas recovery is deep lagoons (with depth more than 2 meters).*
Any comment:	*"2006 IPCC Guidelines for National Greenhouse Gas Inventories" default values (Chapter 6 of Volume 5, Table 6.8).*

Data / Parameter:	$MCF_{ww,PJ,discharge}$
Data unit:	-
Description:	*Methane correction factor based on the discharge pathway of the wastewater in the project scenario (e.g. into sea, river or lake).*
Source of data used:	*Table III.H.1 in AMS-III.H, version 16.*
Value applied:	*0.1*
Justification of the choice of data or description of measurement methods	*In the project scenario, the treated wastewater is discharged into river.*

and procedures actually applied :	
Any comment:	*"2006 IPCC Guidelines for National Greenhouse Gas Inventories" default values (Chapter 6 of Volume 5, Table 6.8).*

Data / Parameter:	$MCF_{ww,treatment,PJ,k\text{-}BR}$
Data unit:	-
Description:	*Methane correction factor for the waste water treatment system k equipped with biogas recovery equipment*
Source of data used:	*Table III.H.1 in AMS-III.H, version 16.*
Value applied:	*0.8*
Justification of the choice of data or description of measurement methods and procedures actually applied :	*Default value for anaerobic reactor without methane recovery.*
Any comment:	*"2006 IPCC Guidelines for National Greenhouse Gas Inventories" default values (Chapter 6 of Volume 5, Table 6.8).*

Data / Parameter:	$\eta_{COD,BL,i}$
Data unit:	-
Description:	*Chemical oxygen demand removal efficiency of the baseline treatment system i*
Source of data used:	*Calculated*
Value applied:	*0.98781*
Justification of the choice of data or description of measurement methods and procedures actually applied :	*According to AMS-III.H, COD removal efficiency shall be determined using historical records of at least one year prior to the project implementation.* $$\eta_{COD,BL,i} = \frac{COD_{inflow,i,y} - COD_{ww,discharge,BL,y}}{COD_{inflow,i,y}}$$
Any comment:	-

Data / Parameter:	$\eta_{BL,thermal}$
Data unit:	%
Description:	*The efficiency of the plant using fossil fuel that would have been used in the absence of the project activity*
Source of data used:	Boiler Efficiency and Equipment Lifetime Report
Value applied:	*0.907*
Justification of the choice of data or description of measurement methods and procedures actually applied :	-
Any comment:	-

Data / Parameter:	***$EF_{FF,CO2}$***
Data unit:	*tCO_2/TJ*
Description:	*The CO_2 emission factor of the fossil fuel that would have been used in the baseline plant.*
Source of data used:	*"2006 IPCC Guidelines for National Greenhouse Gas Inventories" default values (Chapter 2 of Volume 1, Table 1.4).*
Value applied:	*56.1*
Justification of the choice of data or description of measurement methods and procedures actually applied :	*Natural gas is used in the baseline plant.*
Any comment:	-

Data / Parameter:	***$EF_{EL,j,y}$***
Data unit:	*tCO_2/MWh*
Description:	*Emission factor for electricity generation for source j in year y.*
Source of data used:	*Pusat Tenaga Malaysia (PTM)*
Value applied:	*0.672 (Peninsular Malaysia)*
Justification of the choice of data or description of measurement methods and procedures actually applied :	*Option A1 is chosen from "Tool to calculate baseline, project and/or leakage emissions from electricity consumption". The emission factor is calculated based on the ex-ante option of "Tool to calculate the emission factor for an electricity system", version 2.2.0, and the "Study on Grid Connected Electricity Baselines in Malaysia 2008", version 2.0[18], which was published by PTM in March 2010.*
Any comment:	-

Data / Parameter:	***$\rho_{CH4,n}$***
Data unit:	*kg/m^3*
Description:	*Density of methane at normal conditions.*
Source of data used:	*Defaults value from "Tool to determine project emissions from flaring gases containing methane".*
Value applied:	*0.716*
Justification of the choice of data or description of measurement methods and procedures actually applied :	-
Any comment:	-

Data / Parameter:	***UF_{BL}***

[18] *"Study on Grid Connected Electricity Baselines in Malaysia 2008"*,version 2.0, http://cdm.greentechmalaysia.my/up_dir/articles1016,article,1270025735,label_CDM_Baseline_2008.pdf

Data unit:	-
Description:	*Model correction factor to account for model uncertainties (baseline)*
Source of data used:	*Default value from AMS-III.H, version 16.*
Value applied:	*0.89*
Justification of the choice of data or description of measurement methods and procedures actually applied :	*FCCC/SBSTA/2003/10/Add.2, page 25.*
Any comment:	-

Data / Parameter:	***UF_{PJ}***
Data unit:	-
Description:	*Model correction factor to account for model uncertainties (project activity).*
Source of data used:	*Default value from AMS-III.H, version 16.*
Value applied:	*1.12*
Justification of the choice of data or description of measurement methods and procedures actually applied :	-
Any comment:	-

Data / Parameter:	***GWP_{CH4}***
Data unit:	*tCO_2e/tCH_4*
Description:	*Global warming potential for methane*
Source of data used:	*Default value from AMS-III.H, version 16.*
Value applied:	*21*
Justification of the choice of data or description of measurement methods and procedures actually applied :	-
Any comment:	-

Data / Parameter:	***CFE_{ww}***
Data unit:	*Fraction*
Description:	*Capture efficiency of the biogas recovery equipment in the wastewater treatment systems.*
Source of data used:	*Defaults value from AMS-III.H, version 16.*
Value applied:	*0.9*
Justification of the choice of data or description of	-

measurement methods and procedures actually applied :	
Any comment:	-

Data / Parameter:	***$B_{o, ww}$***
Data unit:	*kg CH_4/kg COD*
Description:	*Methane producing capacity of the wastewater.*
Source of data used:	*Default value from AMS-III.H, version 16.*
Value applied:	*0.25*
Justification of the choice of data or description of measurement methods and procedures actually applied :	-
Any comment:	-

B.6.3 Ex-ante calculation of emission reductions:

The total ex-ante emission reductions for the proposed project are calculated as below:

$$ER_{total,y} = ER_y + ER_{thermal,y}$$

Parameter	Description	Value	Unit	Source/ Note
$ER_{total,y}$	total emission reductions for the proposed project in year y	**39,068**	tCO_2e	Calculated
ER_y	emission reductions from the wastewater treatment component in year y	31,937	tCO_2e	See detailed calculation below.
$ER_{thermal,y}$	emission reductions from the heat generation component in year y	7,131	tCO_2e	See detailed calculation below.

1. Wastewater treatment component

The ex-ante emission reductions are estimated as follows:

$$ER_{y,ex\ ante} = BE_{y,ex\ ante} - \left(PE_{y,ex\ ante} + LE_{y,ex\ ante}\right)$$

Parameter	Description	Value	Unit	Source/ Note

$ER_{y,ex\ ante}$	Ex-ante emission reduction in year y	**31,937**	tCO_2e	Calculated
$BE_{y,ex\ ante}$	Ex-ante leakage emissions in year y	41,670	tCO_2e	Calculated below.
$PE_{y,ex\ ante}$	Ex-ante project emissions in year y	9,733	tCO_2e	Calculated below.
$LE_{y,ex\ ante}$	Ex-ante baseline emissions in year y	0	tCO_2e	The equipment of the Project is not transferred from another activity

1.1 Baseline emissions (BE_y)

$$BE_y = BE_{power,y} + BE_{ww,treatment,y} + BE_{s,treatment,y} + BE_{ww,discharge,y} + BE_{s,final,y}$$

Parameter	Description	Value	Unit	Source/ Note
BE_y	Baseline emission in year y	**41,670**	tCO_2e	Calculated
$BE_{power,y}$	Baseline emissions from electricity or fuel consumption in year y	0	tCO_2e	The electricity consumed for the wastewater treatment system is negligible.
$BE_{ww,treatment,y}$	Baseline emissions of the wastewater treatment systems affected by the project activity in year y	41,606	tCO_2e	Calculated
$BE_{s,treatment,y}$	Baseline emissions of the sludge treatment systems affected by the project activity in year y	0	tCO_2e	No involvement of sludge treatment in the baseline scenario
$BE_{ww,discharge,y}$	Baseline methane emissions from degradable organic carbon in treated wastewater discharged into sea/ river/ lake in year y	64	tCO_2e	Calculated
$BE_{s,final,y}$	Baseline methane emissions from anaerobic decay of the final sludge produced in year y	0	tCO_2e	The sludge is given away to farmers for land application

Baseline emissions of the wastewater treatment systems affected by the project activity in year y ($BE_{ww,treatment,y}$)

$$BE_{ww,treatment,y} = \sum_i \left(Q_{ww,i,y} \times COD_{inflow,i,y} \times \eta_{COD,BL,i} \times MCF_{ww,treatment,BL,i}\right) \times B_{o,ww} \times UF_{BL} \times GWP_{CH4}$$

Parameter	Description	Value	Unit	Source/ Note
$BE_{ww,treatment,y}$	Baseline emissions of the wastewater treatment systems affected by the project activity in year y.	**41,606**	tCO_2e	Calculated
$Q_{ww,i,y}$	Volume of wastewater treated in baseline wastewater treatment system i in year y	168,480	m^3	FFB processing amount = 45tFFB/hr Operating hour = 6240 hr/yr Assume $0.6m^3$POME/tFFB
$COD_{inflow,i,y}$	Chemical oxygen demand of the wastewater inflow to the baseline treatment system i in year y	66,879.4	mg/l	Historical data

		0.0668794	t/m^3	-
$\eta_{COD,BL,i}$	COD removal efficiency of the baseline treatment system *i*	0.98781	-	Calculated using equation below: $\frac{COD_{inflow,i,y} - COD_{ww,discharge,BL,y}}{COD_{inflow,i,y}}$
$MCF_{ww,treatment,BL,i}$	Methane correction factor for baseline wastewater treatment systems i	0.8	-	AMS-III.H, Table III.H.1 (Anaerobic deep lagoon)
$B_{o,ww}$	Methane producing capacity of the wastewater	0.25	kg CH_4/ kgCOD	IPCC value as per AMS-III.H
UF_{BL}	Model correction factor to account for model uncertainties	0.89	-	AMS-III.H
GWP_{CH4}	Global Warming Potential for methane	21	tCO_2e/ tCH_4	AMS-III.H

Baseline methane emissions from degradable organic carbon in treated wastewater discharged into sea/ river/ lake in year y (BE$_{ww,discharge,y}$)

$$BE_{ww,,discharge,y} = Q_{ww,y} \times GWP_{CH4} \times B_{o,ww} \times UF_{BL} \times COD_{ww,discharge,BL,y} \times MCF_{ww,BL,discharge}$$

Parameter	Description	Value	Unit	Source/ Note
$BE_{ww,discharge,y}$	Baseline methane emissions from degradable organic carbon in treated wastewater discharged into sea/ river/ lake in year y.	**64**	tCO_2e	Calculated
$Q_{ww,y}$	Volume of treated wastewater discharged in year y	168,480	m^3	FFB processing amount = 45tFFB/yr Operating hour = 6240 hr/yr Assume 0.6m^3POME/tFFB
GWP_{CH4}	Global Warming Potential for methane	21	tCO_2e/ tCH_4	AMS-III.H
$B_{o,ww}$	Methane producing capacity of the wastewater	0.25	kg CH_4/ kgCOD	IPCC value as per AMS-III.H
UF_{BL}	Model correction factor to account for model uncertainties	0.89	-	AMS-III.H
$COD_{ww,discharge,BL,y}$	Chemical oxygen demand of the treated wastewater discharged into sea, river or lake in the baseline situation in the year y.	815.39	mg/l	Historical data
		0.00081539	t/m^3	-
$MCF_{ww, BL, discharge}$	Methane correction factor based on discharge pathway or system in the baseline situation (e.g. into sea, river or lake) of the wastewater	0.1	-	AMS-III.H, Table III.H.1 (discharge of wastewater to river)

1.2 Project activity emissions (PE$_y$)

$$PE_y = \begin{Bmatrix} PE_{power,y} + PE_{ww,treatment,y} + PE_{s,treatment,y} + PE_{ww,discharge,y} + PE_{s,final,y} \\ +PE_{fugitive,y} + PE_{biomass,y} + PE_{flaring,y} \end{Bmatrix}$$

Parameter	Description	Value	Unit	Source/ Note
PE_y	Project activity emissions in the year y	**9,733**	tCO_2e	Calculated
$PE_{power,y}$	Emissions from electricity or fuel consumption in the year y	227	tCO_2e	Calculated
$PE_{ww,treatment,y}$	Methane emissions from wastewater treatment systems affected by the project activity, and not equipped with biogas recovery, in year y	4,654	tCO_2e	Calculated
$PE_{s,treatment,y}$	Methane emissions from sludge treatment systems affected by the project activity, and not equipped with biogas recovery, in year y	0	tCO_2e	The Project does not involve sludge treatment systems.
$PE_{ww,discharge,y}$	Methane emissions from degradable organic carbon in treated wastewater in year y	81	tCO_2e	Calculated
$PE_{s,final,y}$	Methane emissions from anaerobic decay of the final sludge produced in year y	0	tCO_2e	In the project activity, the final sludge produced will be applied for soil application.
$PE_{fugitive,y}$	Methane emissions from biogas release in capture systems in year y	4,770	tCO_2e	Calculated
$PE_{flaring,y}$	Methane emissions due to incomplete flaring in year y	0	tCO_2e	All biogas generated will be used.
$PE_{biomass,y}$	Methane emissions from biomass stored under anaerobic conditions	0	tCO_2e	No biomass storage.

Emissions from electricity or fuel consumption in the year y ($PE_{power,y}$)

$$PE_{power,y} = \sum_j EC_{PJ,j,y} \times EF_{EL,j,y} \times (1 + TDL_{j,y})$$

Parameter	Description	Value	Unit	Source/ Note
$PE_{power,y}$	Project emissions from electricity consumption in year y	**227**	tCO_2/yr	Calculated
$EC_{PJ,j,y}$	Quantity of electricity consumed by the project electricity consumption source j in year y	100	kW	Project's energy consumption
		312	MWh/yr	The plant operates 6days/week, 12 months/year
$EF_{EL,j,y}$	Emission factor for electricity generation for source j in year y	0.672	tCO_2/MWh	*"Study on Grid Connected Electricity Baselines in Malaysia 2008"*, version 2.0
$TDL_{j,y}$	Average technical transmission and distribution losses for providing electricity to source j in year y	8.45%	-	*"Tenaga Nasional Berhad Annual Report 2010"* [19]

[19] *"Tenaga Nasional Berhad Annual Report 2010"* http://www.tnb.com.my/tnb/application/uploads/annualreports/9701b2624e4d83df2799ce3da16134e2.pdf

Methane emissions from wastewater treatment systems affected by the project activity, and not equipped with biogas recovery, in year y ($PE_{ww,treatment,y}$)

$$PE_{ww,treatment,y} = \sum_{i} \left(Q_{ww,k,y} \times COD_{inflow,k,y} \times \eta_{COD,PJ,k} \times MCF_{ww,treatment,PJ,k}\right) \times B_{o,ww} \times UF_{PJ} \times GWP_{CH4}$$

Parameter	Description	Value	Unit	Source/ Note
$PE_{ww,treatment,y}$	Baseline emissions of the wastewater treatment systems affected by the project activity in year y.	**4,654**	tCO_2e	Calculated
$Q_{ww,k,y}$	Volume of wastewater treated in project treatment system k in year y	168,480	m^3	FFB processing amount = 45tFFB/yr Operating hour = 6240 hr/yr Assume $0.6m^3$POME/tFFB
$COD_{inflow,k,y}$	Chemical oxygen demand of the wastewater inflow to the project treatment system k in year y	6,687.94	mg/l	Assume the efficiency of the anaerobic digester is 90%, $COD_{inflow,k,y}$ $= COD_{inflow,i,y} \times (1- 0.9)$
		0.00668794	t/m^3	-
$\eta_{COD,PJ,k}$	Chemical oxygen demand removal efficiency of the project wastewater treatment system *k* in year *y*	0.8781	-	Calculated using equation below: $\frac{COD_{inflow,k,y} - COD_{ww,discharge,PJ,y}}{COD_{inflow,k,y}}$
$MCF_{ww,treatment,PJ,k}$	Methane correction factor for project wastewater treatment systems k	0.8	-	AMS-III.H, Table III.H.1 (Anaerobic deep lagoon)
$B_{o,ww}$	Methane producing capacity of the wastewater	0.25	kg CH_4/ kgCOD	IPCC value as per AMS-III.H
UF_{PJ}	Model correction factor to account for model uncertainties	1.12	-	AMS-III.H
GWP_{CH4}	Global Warming Potential for methane	21	tCO_2e/ tCH_4	AMS-III.H

Methane emissions from degradable organic carbon in treated wastewater in year y ($PE_{ww,discharge,y}$)

Similar to the baseline scenario, treated wastewater will be discharged into river, the methane emissions for the Project are calculated using the following equation:

$$PE_{ww,discharge,y} = \sum_{i} \left(Q_{ww,y} \times COD_{ww,discharge,PJ,y} \times MCF_{ww,PJ,discharge}\right) \times B_{o,ww} \times UF_{PJ} \times GWP_{CH4}$$

Parameter	Description	Value	Unit	Source/ Note
$PE_{ww,discharge,y}$	Methane emissions from degradable organic carbon in treated wastewater discharged into sea/ river/ lake in year y .	**81**	tCO_2e	Calculated
$Q_{ww,y}$	Volume of treated wastewater discharged in year y	168,480	m^3	FFB processing amount = 45tFFB/yr

				Operating hour = 6240 hr/yr Assume 0.6m^{3}POME/tFFB
GWP_{CH4}	Global Warming Potential for methane	21	tCO_2e/ tCH_4	AMS-III.H
$B_{o,ww}$	Methane producing capacity of the wastewater	0.25	kg CH_4/ kgCOD	IPCC value as per AMS-III.H
UF_{PJ}	Model correction factor to account for model uncertainties	1.12	-	AMS-III.H
$COD_{ww,discharge,PJ,y}$	Chemical oxygen demand of the treated wastewater discharged into the sea, river o lake in the project scenario in year y	815.39	mg/l	For simplicity, assume $COD_{ww,discharge,BL,y}$ = $COD_{ww,discharge,PJ,y}$
		0.00081539	t/m^3	-
$MCF_{ww,PJ,discharrge}$	Methane correction factor based on the discharge pathway of the wastewater in the project scenario (e.g. into sea, river or lake)	0.1	-	AMS-III.H Table III.H.1 (discharge to river)

<u>Methane emissions from biogas release in capture systems in year y ($PE_{fugitive,y}$)</u>

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

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

$$MEP_{ww,treatment,y} = Q_{ww,y} \times B_{o,ww} \times UF_{PJ} \times \sum_k COD_{removed,PJ,k,y} \times MCF_{ww,treatment,PJ,k}$$

Parameter	Description	Value	Unit	Source/ Note
$PE_{fugitive,y}$	Methane emissions from biogas release in capture systems in year y.	**4,770**	tCO_2e	Calculated
$PE_{fugitive,ww,y}$	Fugitive emissions through capture inefficiencies in the anaerobic wastewater treatment systems in the year y	4,770	tCO_2e	Calculated
$PE_{fugitive,s,y}$	Fugitive emissions through capture inefficiencies in the anaerobic sludge treatment systems in the year y.	0	tCO_2e	There are no anaerobic sludge treatment systems in the project activity.
CFE_{ww}	Capture efficiency of the biogas recovery equipment in the wastewater treatment systems	0.9	-	AMS-III.H
$MEP_{ww,treatment,y}$	Methane emission potential of wastewater treatment systems equipped with biogas recovery system in year y	2,271.5	t	Calculated
$Q_{ww,y}$	Volume of treated wastewater discharged in year y	168,480	m^3	FFB processing amount = 45tFFB/yr Operating hour = 6240 hr/yr Assume 0.6m^{3}POME/tFFB

$B_{o,ww}$	Methane producing capacity of the wastewater	0.25	kg CH_4/ kgCOD	IPCC value as per AMS-III.H
UF_{PJ}	Model correction factor to account for model uncertainties	1.12	-	AMS-III.H
$COD_{removed,PJ,k,y}$	The chemical oxygen demand removed by the treatment system k of the project activity equipped with biogas recovery in the year y	0.06019	t/m^3	Assume the efficiency of the anaerobic digester is 90%, $COD_{removed,PJ,k,y}$ = $COD_{inflow,i,y}$ × 0.9
$MCF_{ww,treatment,PJ,k}$	Methane correction factor for the project wastewater treatment system k equipped with biogas recovery equipment	0.8	-	AMS-III.H, Table III.H.1 (Anaerobic reactor without methane recovery)
GWP_{CH4}	Global Warming Potential for methane	21	tCO_2e/ tCH_4	AMS-III.H

1.3 Leakage (LE_y)

The equipment of the Project is not transferred from another activity, leakage effects are not considered. Thus, $LE_y = 0$.

2. Heat generation component

As per AMS-I.C, the emission reductions are calculated as follows:

$$ER_{thermal,y} = BE_{thermal,y} - PE_{thermal,y} - LE_{thermal,y}$$

Where:

Parameter	Description	Value	Unit	Source
$ER_{thermal,y}$	Emission reduction in year y	**7,131**	tCO_2e	Calculated.
$BE_{thermal,y}$	Leakage emissions in year y	7,131	tCO_2e	Calculated.
$PE_{thermal,y}$	Project emissions in year y	0	tCO_2e	No natural gas is used.
$LE_{thermal,y}$	Baseline emissions in year y	0	tCO_2e	No transfer of equipment from outside the boundary to the project activity.

2.1 Baseline emissions ($BE_{thermal,y}$)

$$BE_{thermal,CO2,y} = \left(EG_{thermal,y}/\eta_{BL,thermal}\right) \times EF_{FF,CO2}$$

Parameter	Description	Value	Unit	Source
$BE_{thermal,CO2,y}$	The baseline emissions from steam/heat displaced by the project activity during the year *y*	**7,131**	tCO_2	Calculated
$EG_{thermal,y}$	The net quantity of steam/heat supplied by the project activity during the year *y*	115.3	TJ	Annual energy output from the gas burner/boiler

$EF_{FF,CO2}$	The CO_2 emission factor of the fossil fuel that would have been used in the baseline plant; obtained from reliable local or national data if available, otherwise, IPCC default emission factors are used	56.1	tCO_2/TJ	IPCC 2006 default values (Chapter 2 of Volume 2, Table 2.2).
$\eta_{BL,thermal}$	The efficiency of the plant using fossil fuel that would have been used in the absence of the project activity	0.907	-	Boiler Efficiency and Equipment Lifetime Report

2.2 Project emissions($PE_{thermal,y}$)

After the implementation of the project activity, the fossil fuels (natural gas) will be displaced by the biogas captured from the wastewater treatment systems for heat generation. $PE_{thermal,y} = 0$.

2.3 Leakage ($LE_{thermal,y}$)

The energy generating equipment of the Project is not transferred from outside the boundary to the project activity, and the biogas used for heat generation is obtained within the project boundary. $LE_{thermal,y} = 0$.

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

Year	Estimation of project activity emissions (tCO_2e)	Estimation of baseline emissions (tCO_2e)	Estimation of leakage (tCO_2e)	Estimation of overall emission reductions (tCO_2e)
1 (2013)	9,733	48,801	-	39,068
2 (2014)	9,733	48,801	-	39,068
3 (2015)	9,733	48,801	-	39,068
4 (2016)	9,733	48,801	-	39,068
5 (2017)	9,733	48,801	-	39,068
6 (2018)	9,733	48,801	-	39,068
7 (2019)	9,733	48,801	-	39,068
Total (tonnes of CO_2e)	68,131	341,607	-	**273,476**

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

B.7.1 Data and parameters monitored:

According to the *AMS-III.H*, the following parameters shall be monitored:

Data / Parameter:	$Q_{ww,i,y}$
Data unit:	m^3
Description:	*Volume of wastewater treated in year y*
Source of data to be used:	*Magenko Penang*
Value of data	*168,480*

Description of measurement methods and procedures to be applied:	*Measurements are undertaken using flow meters.* *<u>Monitoring frequency</u>* *Monitored continuously (at least hourly measurements are undertaken, if less, confidence/precision level of 90/10 shall be attained).*
QA/QC procedures to be applied:	-
Any comment:	*For ex-post calculation, Volume of wastewater discharged ($Q_{ww,y}$) is equal to the volume of wastewater treated.*

Data / Parameter:	$COD_{ww,untreated,y}$
Data unit:	*Tonnes/m^3*
Description:	*Chemical oxygen demand of the wastewater before the treatment system affected by the project activity*
Source of data to be used:	*Magenko Penang*
Value of data	*0.0668794*
Description of measurement methods and procedures to be applied:	*Measure the COD according to national or international standards. COD is measured through representative sampling. Samples and measurements shall ensure a 90/10 confidence/precision level.* *To meet this 90/10 confidence/precision level comfortably, COD measurements will be carried out on a weekly basis in-house.*
QA/QC procedures to be applied:	-
Any comment:	-

Data / Parameter:	$COD_{ww,treated,y}$
Data unit:	*Tonnes/m^3*
Description:	*Chemical oxygen demand of the wastewater after the treatment system affected by the project activity*
Source of data to be used:	*Magenko Penang*
Value of data	*0.00668794*
Description of measurement methods and procedures to be applied:	*Measure the COD according to national or international standards. COD is measured through representative sampling. Samples and measurements shall ensure a 90/10 confidence/precision level.* *To meet this 90/10 confidence/precision level comfortably, COD measurements will be carried out on a weekly basis in-house.*
QA/QC procedures to be applied:	-
Any comment:	*Used for the calculation of $COD_{removed,PJ,k,y}$ (= $COD_{ww,untreated,y}$ - $COD_{ww,treated,y}$)*

Data / Parameter:	$COD_{discharge,PJ,k,y}$
Data unit:	*Tonnes/m^3*
Description:	*Chemical oxygen demand of the treated wastewater discharged into the sea,*

	river o lake in the project scenario in year y
Source of data to be used:	*Magenko Penang*
Value of data	*0.00081593*
Description of measurement methods and procedures to be applied:	*Measure the COD according to national or international standards, the current practice in Malaysia is to submit monthly results to the Department of Malaysia. COD is measured through representative sampling. Samples and measurements shall ensure a 90/10 confidence/precision level.*
QA/QC procedures to be applied:	-
Any comment:	-

Data / Parameter:	$S_{j,BL,y}$, $S_{final,PJ,y}$
Data unit:	*ton or* m^3
Description:	*Amount of dry matter in the sludge*
Source of data to be used:	*Magenko Penang*
Value of data	*0*
Description of measurement methods and procedures to be applied:	*Measure the total quantity of sludge on a wet basis. The volume* (m^3) *and density or direct weighing may be used to determine the sludge amount (wet basis). Representative samples are taken to determine the moisture content to calculate the total sludge amount on dry basis.* *If the methane emissions from anaerobic decay of the final sludge are to be neglected because the sludge is controlled combusted, disposed of in a landfill with methane recovery, or used for soil application, then the end-use of the final sludge will be monitored during the crediting period.* *Monitoring frequency* *Monitoring of 100% of the sludge amount through continuous or batch measurements and moisture content through representative sampling to ensure the 90/10 confidence/precision level.*
QA/QC procedures to be applied:	-
Any comment:	-

Data / Parameter:	$BG_{burnt,y}$
Data unit:	m^3
Description:	*Total biogas recovered from the anaerobic digester in year y.*
Source of data to be used:	*Calculated (If measured, Magenko Penang)*
Value of data	*N/A*
Description of measurement methods and procedures to be applied:	*As per the methodology AMS-III.H Version 16.0, if the biogas streams flared* ($FV_{RG,h}$) *and utilized* ($Q_{biogas,bb,y}$) *are moniotred separately, the two fractions can be added together to determine the total biogas recovered, without the need to monitor the recovered biogas before the separation. If measured, monitored continuously via flow meter.*
QA/QC procedures to be applied:	*Calibration will be undertaken from one of the following, from most to least preferred:*

	(a) According to the manufacturer's instructions; *(b) According to national / industry standards, if available;* *(c) At least once every three years.*
Any comment:	

Data / Parameter:	$TDL_{j,y}$
Data unit:	-
Description:	*Average technical transmission and distribution losses for providing electricity to source j in year y.*
Source of data to be used:	*Tenaga Nasional Berhad Annual Report*
Value of data	*8.45%*
Description of measurement methods and procedures to be applied:	*According to "Tool to calculate baseline, project and/or leakage emissions from electricity consumption", the transmission and distribution losses are estimated using recent, accurate and reliable data available within the host country.* *Monitoring frequency* *Annually. In the absence of data from the relevant year, most recent figures should be used, but not older than 5 years.*
QA/QC procedures to be applied:	-
Any comment:	*$TDL_{j,y}$ should be estimated for the distribution and transmission networks of the electricity grid of the same voltage as the connection where the proposed CDM project activity is connected to. The technical distribution losses should not contain other types of grid losses (e.g. commercial losses/theft). The distribution losses can either be calculated by the project participants or be based on references from utilities, network operators or other official documentation.*

Data / Parameter:	$EC_{PJ,j,y}$
Data unit:	*MWh*
Description:	*Quantity of electricity consumed by the project electricity consumption source j in year y.*
Source of data to be used:	*Onsite measurements*
Value of data	*312*
Description of measurement methods and procedures to be applied:	*Use electricity meters.* *Monitoring frequency* *Continuously, aggregated at least annually.*
QA/QC procedures to be applied:	*Cross check measurement results with records for sold electricity where relevant.*
Any comment:	-

Data / Parameter:	***End use of the final sludge***
Data unit:	*Text*
Description:	-
Source of data to be used:	*Magenko Penang*
Value of data	*Land application*
Description of measurement methods and procedures to be applied:	*The final use of the sludge, which will be used for land application, will be monitored via sales/gift receipts with the farmers. If end use cannot be verified as either (a) controlled combustion, (b) disposal in a landfill with methane recovery; or (c) soil application, $MCF_{s,final}$ will be determined as per "Emissions from solid waste disposal sites (version 06.0.0)"*
QA/QC procedures to be applied:	-
Any comment:	-

Data / Parameter:	$\eta_{flare-h}$
Data unit:	*%*
Description:	*Flare efficiency in hour h.*
Source of data to be used:	*"Tool to determine project emissions from flaring gases containing methane"*
Value of data	*90%*
Description of measurement methods and procedures to be applied:	*As per the "Tool to determine project emissions from flaring gases containing methane", the flare efficiency for enclosed flare can be determined by either of the following two options:* *(a) Employing default value* *(b) Continuous monitoring* *Regular maintenance shall be carried out to ensure optimal operation of flares*
QA/QC procedures to be applied:	-
Any comment:	-

According to the "*Tool to determine project emissions from flaring gases containing methane"*, the following parameters shall be monitored:

Data / Parameter:	$FV_{RG,h}$
Data unit:	*Nm^3/hour*
Description:	*Volumetric flow rate of the residual gas in dry basis at normal conditions in the hour h*
Source of data to be used:	*Measurements by Magenko Penang using a flow meter*
Value of data	*0*
Description of measurement methods and procedures to be applied:	*Ensure that the same basis (dry or wet) is considered for this measurement and the measurement of volumetric fraction of all components in the residual gas ($fv_{i,h}$) when the residual gas temperature exceeds 60 ℃.*

	As a simplified approach, project participants may only measure the volumetric fraction of methane and consider the difference to 100% as being nitrogen (N_2). <u>*Monitoring frequency*</u> *Continuously. Values to be averaged hourly or at a shorter time interval*
QA/QC procedures to be applied:	*Flow meters are to be periodically calibrated according to the manufacturer's recommendation.*
Any comment:	-

Data / Parameter:	$fv_{i,h}$
Data unit:	-
Description:	*Volumetric fraction of methane in the residual gas on dry basis in hour h where i = CH_4, CO, CO_2, O_2,H_2, N_2.*
Source of data to be used:	*Measurements by Magenko Penang using a continuous gas analyser*
Value of data	*65%*
Description of measurement methods and procedures to be applied:	*Ensure that the same basis (dry or wet) is considered for this measurement and the measurement of the volumetric flow rate of the residual gas ($FV_{RG,h}$) when the residual gas temperature exceeds 60 ℃.* <u>*Monitoring frequency*</u> *Continuously. Values to be averaged hourly or at a shorter time interval*
QA/QC procedures to be applied:	*Analysers must be periodically calibrated according to the manufacturer's recommendation. A zero check and a typical value check should be performed by comparison with a standard certified gas.*
Any comment:	*As a simplified approach, project participants may only measure the methane content of the residual gas and consider the remaining part as N_2.*

Data / Parameter:	$t_{O2,h}$
Data unit:	-
Description:	*Volumetric fraction of O_2 in the exhaust gas of the flare in the hour h*
Source of data to be used:	*Measurements by Magenko using a continuous gas analyser*
Value of data	*N/A*
Description of measurement methods and procedures to be applied:	*Extractive sampling analysers with water and particulates removal devices or in situ analysers for wet basis determination. The point of measurement (sampling point) shall be in the upper section of the flare (80% of total flare height). Sampling shall be conducted with appropriate sampling probes adequate to high temperatures level (e.g. inconel probes). An excessively high temperature at the sampling point (above 700 ℃) may be an indication that the flare is not being adequately operated or that its capacity is not adequate to the actual flow.* <u>*Monitoring frequency*</u> *Continuously. Values to be averaged hourly or at a shorter time interval*
QA/QC procedures to be applied:	*Analysers must be periodically calibrated according to the manufacturer's recommendation. A zero check and a typical value check should be performed*

	by comparison with a standard gas.
Any comment:	*Monitoring of this parameter is only applicable in case of enclosed flares and continuous monitoring of the flare efficiency. If default value is used, this parameter will not be monitored.*

Data / Parameter:	$fv_{CH4,FG,h}$
Data unit:	*mg/m*^{3}
Description:	*Concentration of methane in the exhaust gas of the flare in dry basis at normal conditions in the hour h*
Source of data to be used:	*Measurements by Magenko using a continuous gas analyser*
Value of data	*N/A*
Description of measurement methods and procedures to be applied:	*Extractive sampling analysers with water and particulates removal devices or in situ analysers for wet basis determination. The point of measurement (sampling point) shall be in the upper section of the flare (80% of total flare height). Sampling shall be conducted with appropriate sampling probes adequate to high temperatures level (e.g. inconel probes). An excessively high temperature at the sampling point (above 700 °C) may be an indication that the flare is not being adequately operated or that its capacity is not adequate to the actual flow.* *Monitoring frequency* *Continuously. Values to be averaged hourly or at a shorter time interval*
QA/QC procedures to be applied:	*Analysers must be periodically calibrated according to the manufacturer.s recommendation. A zero check and a typical value check should be performed by comparison with a standard gas.*
Any comment:	*Monitoring of this parameter is only applicable in case of enclosed flares and continuous monitoring of the flare efficiency. If default value is used, this parameter will not be monitored.* *Measurement instruments may read ppmv or % values. To convert from ppmv to mg/m*^{3} *simply multiply by 0.716. 1% equals 10 000 ppmv.*

Data / Parameter:	T_{flare}
Data unit:	*°C*
Description:	*Temperature in the exhaust gas of the flare*
Source of data to be used:	*Magenko Penang*
Value of data	*N/A*
Description of measurement methods and procedures to be	*Measure the temperature of the exhaust gas stream in the flare by a Type N thermocouple. A temperature above 500 °C indicates that a significant amount of gases are still being burnt and that the flare is operating.*

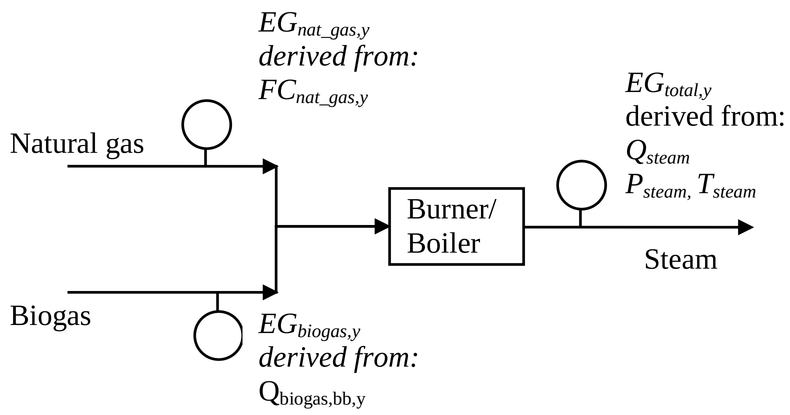
applied:	*Monitoring frequency* *Continuously.*
QA/QC procedures to be applied:	*Thermocouples should be replaced or calibrated every year.*
Any comment:	*An excessively high temperature at the sampling point (above 700 °C) may be an indication that the flare is not being adequately operated or that its capacity is not adequate to the actual flow.*

Data / Parameter:	***Flare operation time***
Data unit:	*minutes*
Description:	*The time length of the flare operation*
Source of data to be used:	*Magenko Penang*
Value of data	*N/A*
Description of measurement methods and procedures to be applied:	*The flame detection period shall be compared to the period of biogas being sent to the flare and monitoring result of temperature in the exhaust gas of the flare (T_{flare}), described in the next table.*
QA/QC procedures to be applied:	*N/A*
Any comment:	*In case of enclosed flares and use of the default value for the flare efficiency, the flare efficiency in the hour h ($\eta_{flare,h}$) is:* • *0% if the temperature in the exhaust gas of the flare (Tflare) is below 500 °C for more than 20 minutes during the hour h* • *50%, if the temperature in the exhaust gas of the flare (Tflare) is above 500 °C for more than 40 minutes during the hour h, but the manufacturer's specifications on proper operation of the flare are not met at any point in time during the hour h.* • *90%, if the temperature in the exhaust gas of the flare (Tflare) is above 500 °C for more than 40 minutes during the hour h and the manufacturer's specifications on proper operation of the flare are met continuously during the hour h.*

Data / Parameter:	***Other flare operation parameters***
Data unit:	-
Description:	*This should include all data and parameters that are required to monitor whether the flare operates within the range of operating conditions according to the manufacturer's specifications including a flame detector in case of open flares.*
Source of data to be used:	*Measurements by project participants*
Value of data	*N/A*
Description of measurement methods and procedures to be	*Monitoring frequency* *Continuously*

applied:	
QA/QC procedures to be applied:	-
Any comment:	*Only applicable in case of use of a default value*

According to the *AMS-I.C*, the following parameters shall be monitored:

Data / Parameter:	$EG_{thermal,y}$
Data unit:	*TJ*
Description:	*The net quantity of thermal energy supplied by the project activity during the year y*
Source of data to be used:	*Calculated*
Value of data	*115.3*
Description of measurement methods and procedures to be applied:	*For ex-post, $EG_{thermal,y}$ will be determined using the following equation:*  $$EG_{thermal,y} = EG_{total,y} \times \frac{EG_{biogas,bb,y}}{(EG_{biogas,bb,y} + EG_{nat\_gas,y})}$$ *Where* $EG_{total,y}$ *The total quantity of thermal energy supplied by the burner/burner (using both biogas and fossil fuel) during the year y* $EG_{biogas,y}$ *The quantity of thermal energy generated by biogas during the year y (TJ)* $EG_{nat\_gas,y}$ *The quantity of thermal energy generated by natural gas during the year y (TJ)*
QA/QC procedures to be applied:	-
Any comment:	-

Data / Parameter:	$EG_{total,y}$
Data unit:	*TJ*
Description:	*The total quantity of thermal energy supplied by the burner/burner (using both*

	biogas and natural gas) during the year y
Source of data to be used:	*Calculated*
Value of data	*N/A*
Description of measurement methods and procedures to be applied:	*Heat generation is determined as the difference of the enthalpy of the steam or hot fluid and/or gases generated by the heat generation equipment and the sum of the enthalpies of the feed-fluid and/or gases blow-down and any condensate returns. The respective enthalpies should be determined based on the mass (or volume) flows, the temperatures and, in case of superheated steam, the pressure. Steam tables or appropriate thermodynamic equations may be used to calculate the enthalpy as a function of temperature and pressure.* *In case of equipment that produces hot water/oil this is expressed as difference in the enthalpy between the hot water/oil supplied to and returned by the plant.* *In case of equipment that produces hot gases or combustion gases, this is expressed as difference in the enthalpy between the hot gas produced and all streams supplied to the plant. The enthalpy of all relevant streams shall be determined based on the monitored mass flow, temperature, pressure, density and specific heat of the gas.* *Metering the energy produced by a sample of the systems where the simplified baseline is based on the energy produced multiplied by an emission coefficient.* *Monitoring frequency* *Continuous monitoring, aggregated annually*
QA/QC procedures to be applied:	*Measuring equipment should be certified to national or IEC standards and calibrated according to the national standards and reference points or IEC standards and recalibrated at appropriate intervals according to manufacturer specifications, but at least once in three years.*
Any comment:	*The total thermal energy (steam) generated is determined by:* $EG_{total,y} = Q_{steam} \times \Delta h_{steam}$ *Where* Q_{steam} *Quantity of steam generated by the burner/ boiler* (Nm^3/hr) Δh_{steam} *Difference of the enthalpy of the steam generated by the burner/boiler and the enthalpy of the feed-water (kJ/ mass or volume flow)*

Data / Parameter:	$\boldsymbol{Q_{steam}}$
Data unit:	Nm^3/hr
Description:	*Quantity of steam generated by the heat generation equipment*
Source of data to be used:	*Measurements by Magenko Penang using calibrated meters.*
Value of data	*N/A*

Description of measurement methods and procedures to be applied:	*Calibration shall be as per the relevant paragraphs of the "General guidelines to SSC CDM methodologies". If applicable, measurement results shall be cross checked with records for sold/purchased electricity (e.g. invoices/receipts).* *Monitoring frequency* *Continuous monitoring, integrated hourly and at least monthly recording.*
QA/QC procedures to be applied:	*Measuring equipment should be certified to national or IEC standards and calibrated according to the national standards and reference points or IEC standards and recalibrated at appropriate intervals according to manufacturer specifications, but at least once in three years.*
Any comment:	-

Data / Parameter:	T_{steam}
Data unit:	*°C*
Description:	*Temperature of steam generated by the heat generation equipment*
Source of data to be used:	*Measurements by Magenko Penang using calibrated meters.*
Value of data	*N/A*
Description of measurement methods and procedures to be applied:	*Calibration shall be as per the relevant paragraphs of the "General guidelines to SSC CDM methodologies".* *Monitoring frequency* *Continuous monitoring, integrated hourly and at least monthly recording.*
QA/QC procedures to be applied:	*Measuring equipment should be certified to national or IEC standards and calibrated according to the national standards and reference points or IEC standards and recalibrated at appropriate intervals according to manufacturer specifications, but at least once in three years.*
Any comment:	-

Data / Parameter:	P_{steam}
Data unit:	Kg/cm^2
Description:	*Pressure of steam generated by the heat generation equipment*
Source of data to be used:	*Measurements by Magenko Penang using calibrated meters.*
Value of data	*N/A*
Description of measurement methods and procedures to be applied:	*Calibration shall be as per the relevant paragraphs of the "General guidelines to SSC CDM methodologies".* *Monitoring frequency* *Continuous monitoring, integrated hourly and at least monthly recording.*
QA/QC procedures to be applied:	-
Any comment:	-

Data / Parameter:	T_{water}
Data unit:	*°C*
Description:	*Temperature of feed water sent to the heat generation equipment*

Source of data to be used:	*Measurements by Magenko Penang using calibrated meters.*
Value of data	*N/A*
Description of measurement methods and procedures to be applied:	*Calibration shall be as per the relevant paragraphs of the "General guidelines to SSC CDM methodologies".* *<u>Monitoring frequency</u>* *Continuous monitoring, integrated hourly and at least monthly recording.*
QA/QC procedures to be applied:	*Measuring equipment should be certified to national or IEC standards and calibrated according to the national standards and reference points or IEC standards and recalibrated at appropriate intervals according to manufacturer specifications, but at least once in three years.*
Any comment:	-

Data / Parameter:	FC_{nat_gasy}
Data unit:	*Mass or volume unit per year (e.g. ton/yr or m^3/yr)*
Description:	*Quantity of thermal energy generated by natural gas during the year y*
Source of data to be used:	*Onsite measurements*
Value of data	*N/A*
Description of measurement methods and procedures to be applied:	*According to "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion", the monitoring procedures are:* • *Use either mass or volume meters. In cases where fuel is supplied from small daily tanks, rulers can be used to determine mass or volume of the fuel consumed, with the following conditions: The ruler gauge must be part of the daily tank and calibrated at least once a year and have a book of control for recording the measurements (on a daily basis or per shift);* • *Accessories such as transducers, sonar and piezoelectronic devices are accepted if they are properly calibrated with the ruler gauge and receiving a reasonable maintenance;* • *In case of daily tanks with pre-heaters for heavy oil, the calibration will be made with the system at typical operational conditions.* *<u>Monitoring frequency</u>* *Continuously.*
QA/QC procedures to be applied:	*The consistency of metered fuel consumption quantities should be cross-checked by an annual energy balance that is based on purchased quantities and stock changes.* *Where the purchased fuel invoices can be identified specifically for the CDM project, the metered fuel consumption quantities should also be cross-checked with available purchase invoices from the financial records.*
Any comment:	*This is used to calculate the quantity of thermal energy generated by fossil fuel:* $EG_{nat\_gas,y} = FC_{nat\_gas,y} \times NCV_{nat\_gas}$ *Where*

	NCV_{nat_gas} The net calorific value of natural gas (GJ/mass or volume unit)
Data / Parameter:	**$Q_{biogas,bb,y}$**
Data unit:	*Nm^3*
Description:	*Quantity of biogas sent to the burner/boiler during year y*
Source of data to be used:	*Measurements by Magenko Penang using a flow meter*
Value of data	*N/A*
Description of measurement methods and procedures to be applied:	*Monitored continuously.*
QA/QC procedures to be applied:	*Flow meters are to be periodically calibrated according to the manufacturer's recommendation.* *The project activity is exporting heat to other facilities, the metering shall be carried out at the recipients end and measurement results shall be cross checked with records for sold/purchased biogas (e.g. invoices/receipts).*
Any comment:	*This is used to calculate the quantity of thermal energy generated by biogas:* $EG_{biogas,bb,y} = Q_{biogas,bb,y} \times NCV_{biogas}$ *Where* *NCV_{nat_gas} The net calorific value of biogas(GJ/mass or volume unit)*

Data / Parameter:	**NCV_{nat_gas}**
Data unit:	*GJ/mass or volume unit*
Description:	*Net calorific value of natural gas*
Source of data to be used:	*"Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion"*
Value of data	*N/A*
Description of measurement methods and procedures to be applied:	*The following data sources may be used if the relevant conditions apply:*

Data source	Conditions for using the data source
a) Values provided by fuel supplier in invoices	*This is the preferred source if the carbon fraction of the fuel is not provided*
b) Measurement by the project participants	*If a) is not available*
c) Reginal or national default values	*If a) is not available* *These sources can only be used for liquid fuels and should be based on well documented, reliable sources (such as national energy balances).*
d) IPCC default value at the upper limit of the uncertainty at a 95% confidence interval as provided in Table 1.2 of Chapter 1 of Vol.2 (Energy) of the 2006 IPCC	*If a) is not available*

	Guidelines on National GHG Inventories *For a) and b): Measurements should be undertaken in line with national or international fuel standards* *Monitoring frequency* *For a) and b): The NCV should be obtained for each fuel delivery, from which weighted average annual values should be calculated* *For c): Review appropriateness of the values annually* *For d): Any future revision of the IPCC Guidelines should be taken into account*
QA/QC procedures to be applied:	*Verify if the values under a), b) and c) are within the uncertainty range of the IPCC default values as provided in Table 1.2, Vol. 2 of the 2006 IPCC Guidelines. If the values fall below this range collect additional information from the testing laboratory to justify the outcome or conduct additional measurements. The laboratories in a), b) or c) should have ISO17025 accreditation or justify that they can comply with similar quality standards.*
Any comment:	-

Data / Parameter:	***NCV_{biogas}***
Data unit:	*GJ/Mg*
Description:	*Net calorific value of biogas*
Source of data to be used:	*"Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion"*
Value of data	*50.4*
Description of measurement methods and procedures to be applied:	*IPCC default value at the upper limit of the uncertainty at a 95% confidence interval as provided in Table 1.2 of Chapter 1 of Vol.2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories* *For a) and b): Measurements should be undertaken in line with national or international fuel standards* *Monitoring frequency* *Any future revision of the IPCC Guidelines should be taken into account*
QA/QC procedures to be applied:	-
Any comment:	-

B.7.2 Description of the monitoring plan:

1. Implementation of the monitoring plan

The staff from Magenko Penang will be responsible for implementation of the monitoring plan. The planned operation and management structure for the Project is described in Figure 3 below.

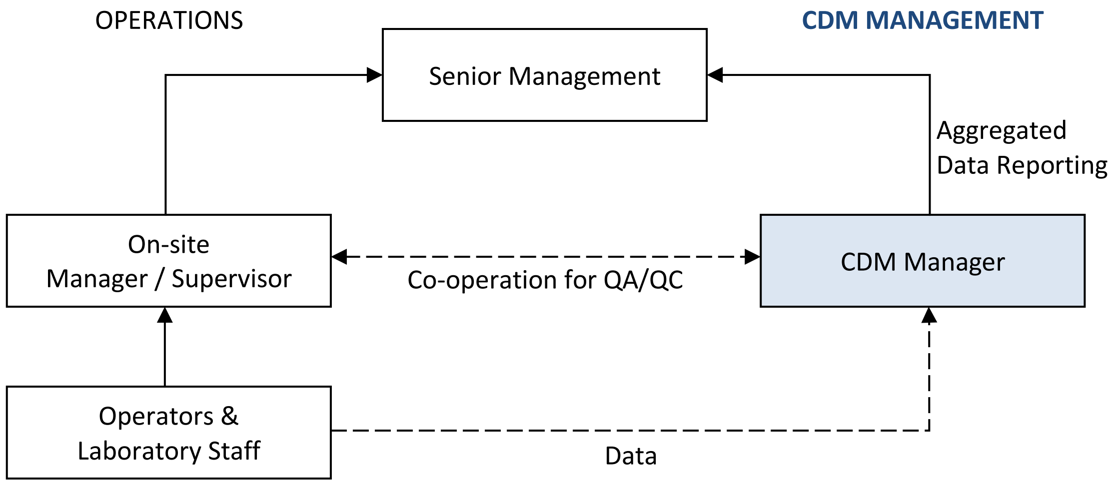


Figure 3: Operation and Management Structure for Monitoring Activities

2. Staff training

Staff will be trained on the safe and proper operation of major equipments such as the anaerobic digester and enclosed flare, and will also be trained on the monitoring equipment installed. Such training will be carried out prior to the commissioning of the Project plant, and will be documented.

3. Data recording and archiving

(a) Data recording

Recording will be done online for as many parameters as possible, though the exact meters to be connected is yet to be determined. For manual records (including backup manual recording when there is an error with the online system for parameters normally recorded online), recording will be carried out once daily where measurement is continuous, and as and when measurements occur for when measurement is done on batch basis (e.g. weekly COD measurements).

(b) Data archiving

All monitored data will be archived for the duration of the crediting period and 2 years thereafter.

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

The baseline study was completed in 03/09/2012 by:

Carbon Partners Asiatica
Suite 1402, World Commerce Centre,
11 Canton Road, Tsim Sha Tsui,
Kowloon, Hong Kong
(Tel: +852 3101 0131/ Fax: +852 3622 1360)
kyoko.tochikawa@cp-asiatica.com; margaret.wong@cp-asiatica.com

Carbon Partners Asiatica is the CDM advisor to the Project and is not a project participant.

SECTION C. Duration of the project activity / crediting period

C.1 Duration of the project activity:

C.1.1. Starting date of the project activity:

01/06/2011

The starting date of the project activity is defined as the date on which the investment agreement between Magenko and UOP was signed.

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

14 years

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

C.2.1. Renewable crediting period

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

01/01/2013 or immediately from the date of project registration, whichever is the latest.

C.2.1.2. Length of the first crediting period:

7 years

C.2.2. Fixed crediting period:

C.2.2.1. Starting date:

Not applicable.

C.2.2.2. Length:

Not applicable.

SECTION D. Environmental impacts

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

The upgrading wastewater treatment system for POME is not listed as activities prescribed under *Environmental Quality (Prescribed Activities) (Environmental Impact Assessment) Order 1987"*[20], thus an environmental impact assessment (EIA) for the proposed project is not required by the host country. The negative environmental impacts of the Project are considered to be insignificant. A potential risk of explosions or leakage of methane from the biogas recovery system is identified. Measurements to mitigate such risk include proper design and construction, implementation of safety plan and regular monitoring during operation.

Apart from the aforementioned negative environmental impact, the Project will indeed contribute to positive environmental impacts, as follows:

Improving air quality: Treating POME in the open lagoons under anaerobic condition results in odor problems. Implementation of the new wastewater treatment system will treat POME in an anaerobic digester and capture the biogas generated in a closed tank. The COD level of the POME entering the existing open lagoons will be lowered and air quality will be improved by reducing the emission of toxic odour gas.

Reducing GHGs emission: The biogas captured greatly reduces the amount of methane released from the anaerobic open lagoons. In addition, the biogas generated, which is considered as clean renewable energy fuel, will be utilized to displace thermal generation by natural gas for the paper mill.

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:

No environmental impacts are considered significant by the project participants or the host Party.

[20] Department of Environment (Malaysian) http://www.doe.gov.my/v2/files/penilaian26/Appendix_2.pdf

SECTION E. Stakeholders' comments

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

A stakeholder meeting was held by Magenko Penang on the 21 June 2011. The purpose of the meeting is to provide a forum for local stakeholders who may be affected by the Project to learn about, ask questions of and express their opinions about the Project.

To encourage active participation, the announcements of the consultation meeting were published in the local newspaper, The New Straits Times paper, on 10 June 2011, as shown below.

FRIDAY, JUNE 10, 2011

223. General Notices

INVITATION TO STAKEHOLDER MEETING

On 21 JUNE 2011, 9:00am – 1:00pm, UOP Mill at Nibong Tebal Biogas Recovery and Utilisation Project for United Oil Palm Industries Sdn Bhd, Nibong Tebal, Penang

United Oil Palm Industries Sdn Bhd (UOP) is an existing independent private palm oil mill located at Jalan Bandar Baru, Sungai Kecil, 14300 Nibong Tebal, Penang, Malaysia.

Working in collaboration with Magenko Renewables (Penang) Sdn Bhd, UOP plans to install and operate an anaerobic digester to treat the palm oil mill effluent (POME), and a biogas recovery system to capture the methane gas that is generated from anaerobic digestion.

The successful implementation of this project will improve the efficiency in POME treatment, reduce greenhouse gas emissions, as well as the production of renewable energy (biogas) which will be utilized in a boiler of a neighboring paper mill.

This project will also enable UOP and Magenko to be eligible for the Clean Development Mechanism (CDM), which is a financing mechanism under the Kyoto Protocol.

UOP and Magenko cordially invite you to a stakeholder meeting to introduce and discuss further on the proposed biogas recovery and utilization project. The details of the meeting are as follows :-

Date : **21st June 2011 (Tuesday)**

Time : **9:00 am – 12:00 pm (followed by lunch)**

Venue : **UOP Palm Oil Mill, 878, Jalan Bandar Baru, Sungai Kecil, 14300 Nibong Tebal, Penang.**

Please contact **Mr. Liew (Tel: +6 016 225 1450)** or **Mr. Loi (+012 430 6662)** if you would like to attend the meeting or require any clarification.

Figure 4: Invitation to the consultation meeting

The meeting began with the presentations on the description of the Mill's operation and explanation of the CDM, followed by a site tour and a question and answer session. Questionnaires were handed out to obtain participants' opinion.

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Figure 5: Stakeholders consultation meetings

E.2. Summary of the comments received:

During the meeting, some local stakeholders raised questions related to the Project, all the questions were answered and no subsequent comments were received after discussion. The questions raised during the stakeholder meeting and the response from project owner are summarised in the table below:

Table 12: Q&A session summary

Questions	Response
14 years of operation? Why?	UOP opted for 14 years. After this the project will be handed over to UOP.
Two types of anaerobic digestor technology were explained. Which will the project choose?	There are several things to consider including: 1. Cost 2. Available land 3. Other site and wastewater conditions Technology will be decided in several weeks.
Would the sludge be reduced?	More sludge will be produced. The system will be designed to desludge.
Does bacteria need to be added for the	Generally POME does not need additional bacteria.

anaerobic digestion.	
Would you train any locals to operate anaerobic digester?	Yes. The project will need to train personnel to: 1. Make sure volatile acid does not building up 2. Be familiar with SCADA monitoring system
How long would you take to recover system if something goes wrong?	Digester failure can technically occur, but there is little chance of actual occurrence as digester and lagoons are large and have more tolerance.
What is the total carbon equivalent?	Approximately 25,000 CERs/ year
Are you aware of Feed in Tariff?	Feed in Tariff is relevant to grid power sales. After consideration, grid power generation was considered to be infeasible for the project.

Questionnaires were distributed during the stakeholder meeting and the following table summarized the responses of the stakeholder.

Table 13: Questionnaire summary

Questions	**Summarised comments from stakeholders**
Do you have any comments about the environment in which you live? Please describe.	In general, the environmental conditions are not considered as bad. However, some stakeholders think that the environment has been getting worse, and some have concerns on the water quality (rivers), air quality and drainage problems.
Do you believe your comment in question above is related to UOP's activities? If yes, please elaborate.	A few of the stakeholders were concerned on the waste (effluent) discharge from the mill to the air and water. Most of the others believe the environmental problems stated above are not related to UOP's activities.
Are you happy that UOP's project will improve the treatment of wastewater and therefore the waterways?	Over 90% of the interviewees are happy with the implementation of the Project and believe it will improve the environment in the future.
Would you like to see more companies follow the example of UOP to help clean up the environment?	Over 90% of the interviewees would like to see more companies follow the example of UOP to help clean up the environment.
Any other comments	The comments received regarding the Project were all positive. Some suggestions were made, such as long term careful maintenance of plant operation.

The results of the survey revealed that the participants believed the proposed project activity would help improving the environmental conditions. Overall, the stakeholders were all supportive towards the Project implementation.

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

The stakeholders supported the construction of Project and there no negative comments were received. Thus no further action was deemed necessary.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

Organization:	Magenko Renewables (Penang) Sdn. Bhd.
Street/P.O.Box:	
Building:	Level 30, The Gardens North Tower
City:	Mid Valley City
State/Region:	Kuala Lumpur
Postfix/ZIP:	59200
Country:	Malaysia
Telephone:	+603 2035 9628
FAX:	+603 2035 9798
E-Mail:	Magenko@enerpro.eu.com
URL:	
Represented by:	
Title:	General Manager
Salutation:	Mr.
Last Name:	Liew
Middle Name:	-
First Name:	Shan Sern
Department:	
Mobile:	+6 016-225 1450
Direct FAX:	
Direct tel:	
Personal E-Mail:	shansern.liew@magenko.eu.com

Organization:	Enerpro Carbon SA
Street/P.O.Box:	2 Kapodistriou Street & Akti Posidonos
Building:	
City:	Piraeus
State/Region:	
Postfix/ZIP:	18531
Country:	Greece
Telephone:	+30 210 4274022
FAX:	+30 210 4220029
E-Mail:	enerpro@enerpro.eu.com
URL:	
Represented by:	Matthew C Los
Title:	CEO
Salutation:	
Last Name:	Los
Middle Name:	C
First Name:	Matthew
Department:	
Mobile:	

Direct FAX:	
Direct tel:	
Personal E-Mail:	enerpro@enerpro.eu.com

Annex 2

INFORMATION REGARDING PUBLIC FUNDING

The Project will not receive any public funding.

Annex 3

BASELINE INFORMATION

No additional information.

Annex 4

MONITORING INFORMATION

No additional information.

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