MONITORING REPORT FORM (CDM-MR) *
Version 01 - in effect as of: 28/09/2010

CONTENTS

* as contained within the document entitled "Guidelines for completing the monitoring report form (CDM-MR)" (EB 54 meeting report, annex 34).

MONITORING REPORT
Version No.: 08, 21/03/12

Methane Recovery and Utilization at United Plantations Berhad, Jendarata Palm Oil Mill, Malaysia
UNFCCC Reg. No: 1153
Period No.: 02, (01/05/2009 – 31/01/2011)

SECTION A. General description of the project activity

A.1. Brief description of the project activity:

This monitoring report is prepared for the project titled "Methane Recovery and Utilization at United Plantations Berhad, Jendarata Palm Oil Mill, Malaysia", located in the state of Perak, Malaysia. The project was started on 1st January 2007 and was registered with UNFCCC with the registration number **1153** on 8th November 2007.

In the baseline scenario, POME is treated using deep open anaerobic lagoons, followed by facultative and aerobic treatment in shallow lagoons. The treated effluent is finally used for land application in the oil palm plantation. This process is similar to the baseline scenario. The discharge for the effluent is in compliance with the Effluent Discharge Standards of the Malaysian Department of Environment[1].

The project activity is a biogas comprising closed continuous-flow stirred tanks (CSTR) anaerobic digester for the treatment of POME. The biogas generated will be supplied to the nearby palm oil refinery, Unitata, where the biogas is combusted in a steam boiler to generate steam for the refinery process. The biogas used in the refinery boiler will displace the consumption of fuel oil. Excess gas is flared off in an open flare. Effluent from the anaerobic digester tanks will be dischargeed into the existing aerobic lagoons, where it is treated before final discharge to land application.

Key Information

Project Title	Methane Recovery and utilisation at United Plantations Berhad, Jendarata Palm Oil Mill, Malaysia
Project Registration Number	1153
CDM Registration Date	08/11/07
Project Starting Date	01/01/07
Project Host	United Plantations Bhd
Project Participants	Danish Ministry of Climate and Energy / Danish Energy Agency
Crediting Period	08/11/07 – 07/11/14 (7 years - Renewable)

[1] Environmental Quality Act 1974: Environmental Quality (Prescribed Premises) (Crude Palm Oil) Regulations 1977

Project Location	United Plantation Berhad, Jendarata Estate, 36009 Teluk Intan, Perak Darul Ridzuan, Malaysia.

Monitoring Period	01/05/09 – 31/01/2011 (21 months)
Monitoring Report Number	02
Reporting Date	21/03/2012

Methodologies Used	AM0013 ver. 04
Emission Reductions in reporting period	60,569 tCO_{2eq}
Name of person/entity preparing the monitoring report	**Henrik Rytter Jensen and Yogaanandh Tanggaraju** Danish Energy Management 37-1, The Capsquare Residences, No.2, Persiaran Capsquare, 50100 Kuala Lumpur, Malaysia Tel : +603 2694 3033 Fax : +603 2694 4033 E-mail: hrj@dem.dk; yat@dem.dk

A.2. 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)	**Private entity: United Plantations Bhd**	**No**
Denmark	**Public Entity: Danish Ministry of Climate and Energy / Danish Energy Agency**	**No**

A.3. Location of the project activity:

United Plantation Berhad,
Jendarata Estate,
36009 Teluk Intan,
Perak Darul Ridzuan, Malaysia.

GPS Coordinates: *$3^0$50’ 9” N and 100^{0}57’ 90” E*

A.4. Technical description of the project

The biogas plant, which mainly constitutes the Continuous-flow Stirred Tank Reactors (CSTR), biogas burner (biogas boiler) and open flare system, started operations on 1st January 2007. The plant was fully completed in September 2006. The testing and commissioning was carried out from September – December 2006. The testing and commissioning activity was undertaken jointly by the main contractor Novaviro Technologies and the sub-contractor Watermech Engineering.

Continuous-flow Stirred Tank Reactors

A closed tank anaerobic digestion technology, based on the continuous flow stirred tank reactor system (CSTR) with sludge return design, is implemented for the palm oil mill effluent (POME) treatment at United Plantations Jendarata Palm Oil Mill to displace the treatment of POME in the existing deep open lagoon system for anaerobic digestion. The CSTR system is equipped with a dual-function complete mixing mechanism, comprising pump-aided circulation and gas-lifting mixing, to maximize the anaerobic digestion efficiency. The complete-mixed system facilitates long-term continuous operations without needs of any interruptions for sludge removal. The anaerobic digestion will be operating under mesophilic conditions with temperature ranging from 35-40^{0}C. The digester system for the project activity is designed with a hydraulic retention time of minimum 18 days. The floating roof design for the tanks allows a significant volume of buffer storage capacity for the biogas.

Biogas Burner

The biogas captured is mainly utilized for steam generation using the existing 10 t/h fuel oil-fired Mashall Boiler at Unitata Berhad, an associated company located adjacent to UP Jendarata Palm Oil Mill. The boiler is fitted with a Dunphy dual burner with automatic control, which allows biogas combustion for steam generation, at approximately 11 barg. The biogas displaces the use of medium fuel oil for the boiler at Unitata Berhad.

Open-flare system

Excess biogas from the digesters is flared using an open flare system, where flaring efficiency is 50% based on ‘’Tool to determine project emissions from flaring gases containing methane’’ (ver. 01).

Nevertheless, due to project participants failing to install a continuous methane analyzer, where the values have to be averaged hourly or a shorter time interval to monitor the methane fraction in the biogas flared, the flare efficiency will be estimated to be 0%; estimated conservatively.

Project Layout

The project 27 parameters registered under the monitoring plan of the PDD.

- Flow rate of organic wastewater into the digester (F_{dig}) – **F1**
- COD concentration of organic wastewater into the digester ($COD_{c,baseline}$) – **COD1**
- COD concentration of the effluent that leaves the lagoon ($COD_{a,out}$) – **COD2**
- COD concentration of the effluent that enters the lagoon which is assumed to be equal to the COD input to the digesters ($COD_{a,in}$) – **COD 1** (2)
- Temperature of lagoon[2] (T_{lag})
- Depth of lagoon (D_{lag}) – *Depth indicator*
- Quantity of thermal energy that would be consumed in year y at the project site in the absence of the project activity using fossil fuel ($HG_{Bl,y}$) – **F5**
- Operating hours per year of the refinery boiler fired on biogas (h_{boiler})
- Operating hours per year of the refinery using steam from biogas boiler ($H_{refinery}$)
- Flow rate of organic wastewater from the digester (F_{dig_out}) – **F1(2)**
- COD concentration in discharged effluent from digester (COD_{c,dig_out}) – **COD2 (2)**
- Amount of electricity in the year y that is consumed at the project site for the project activity ($EL_{Pr,y}$) – **E1**
- Flow rate of sludge applied to land (F_{la}) – **F7**
- COD concentrations in sludge used for land application ($COD_{c,la}$)– **COD3**
- Amount of biogas collected in the outlet of the bio-digester measured using a continuous flow meter (FR_{bio}) – **F3**
- Percentage of biogas that is methane in the outlet of the bio-digester (PCH4,bio) – **CH1**
- Flow rate of biogas entering the flare ($FR_{f,inlet}$) – **F2**
- Project emissions from flaring of the residual gas stream ($PE_{flare,y}$)
- Detection of flame in the open flare being on or off (Flame detection)
- Flow rate of the biogas entering the heat generation equipment ($FR_{e,inlet}$) – **F4**
- Flow rate of the heat generation equipment stack gases ($FR_{e,s}$) – **F6**
- Methane content in stack gas of heat generation equipment ($P_{CH4,e,s}$) – **CH3**[3]
- Fraction of time gas is combusted in the heat generation equipment ($T_{comb,e}$)
- Amount of sludge applied to land (S_o) – **TSS**
- Nitrogen content in the sludge used for land application, for estimating N_2O emission in project emission (NC) – **N**
- Regulations and incentives relevant to effluent
- Detection of physical leakage of digester tanks

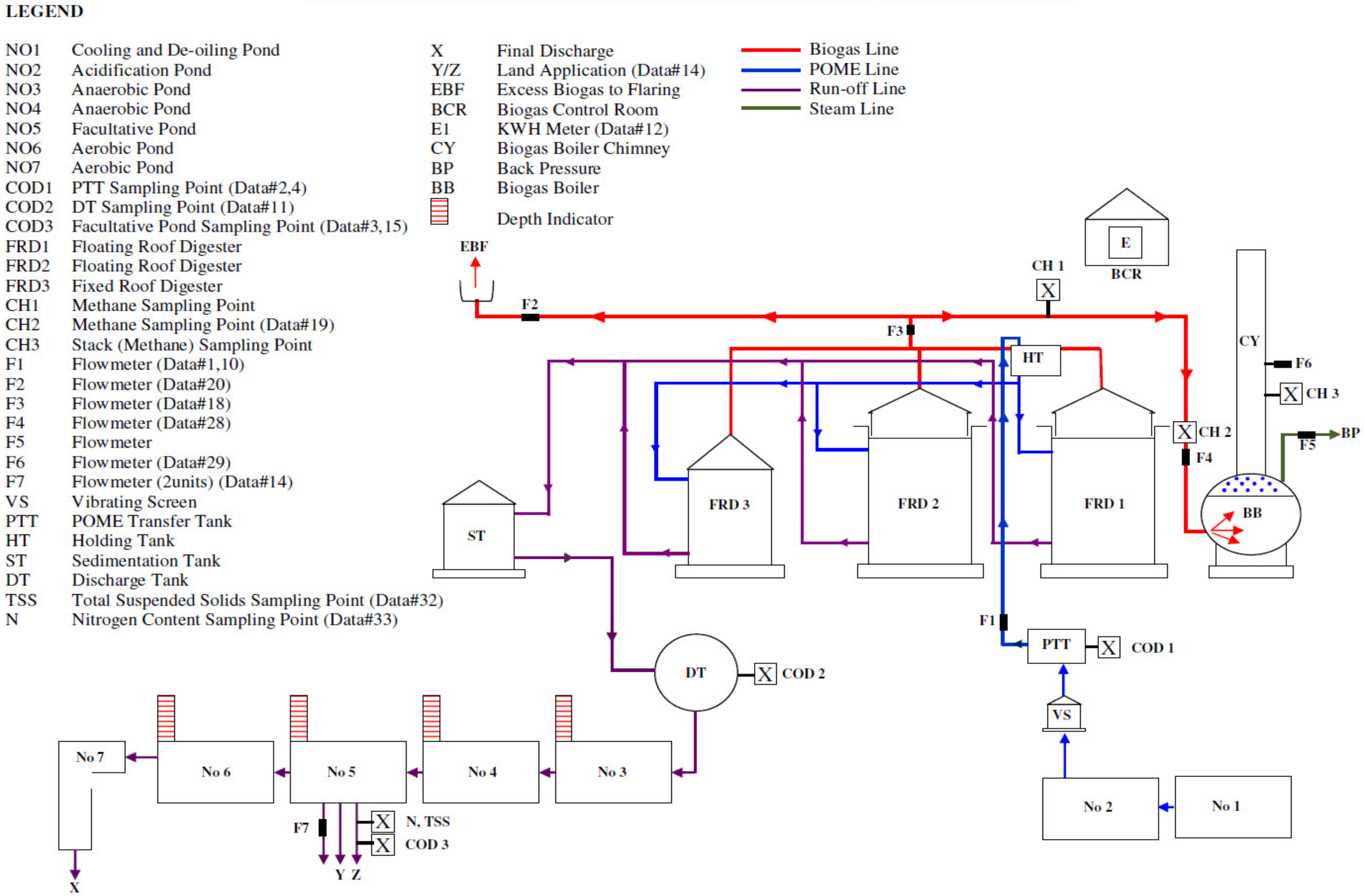
---

[2] Data from Malaysian Meteorological Services for Sitiawan district (Perak state) is used to monitor this parameter

[3] Quarterly stack analysis is conducted using accredited (ISO 17025/SAMM) laboratory. Results show no methane detection to up to 0.01% (vol/vol).

Figure 1: Flowchart of the project with main components and labels for monitoring points.

BIOGAS PRODUCTION PLANT AND APPLICATION OF DIGESTED POME



A.5. Title, reference and version of the baseline and monitoring methodology applied to the project activity:

The approved baseline and monitoring methodology AM0013 Ver. 4: "Avoided methane emissions from organic waste-water treatment" is applied to the project activity.

A.6. Registration date of the project activity:

08/11/07

A.7. Crediting period of the project activity and related information (start date and choice of crediting period):

08/11/07 – 07/11/14 (7 years, Renewable)

A.8. Name of responsible person(s)/entity(ies):

Henrik Rytter Jensen
Danish Energy Management
37-1, The Capsquare Residences
No.2, Persiaran Capsquare
50100 Kuala Lumpur, Malaysia
Tel : +603 2694 3033
Fax : +603 2694 4033
E-mail: hrj@dem.dk

Yogaanandh Tanggaraju
Danish Energy Management
37-1, The Capsquare Residences
No.2, Persiaran Capsquare
50100 Kuala Lumpur, Malaysia
Tel : +603 2694 3033
Fax : +603 2694 4033
E-mail: yat@dem.dk

SECTION B. Implementation of the project activity

B.1. Implementation status of the project activity

Starting date of the operation of the project activity

The project underwent testing and commissioning between the months September and December 2006. The project became fully operational and started on the 1st January 2007. The project starting date was before the project registration date (08/11/07). All equipment pertaining to the project has been in operating mode since the project start date.

The data presented in this second monitoring report is covering the period from 01/05/09 to 31/01/2011; the period where emission reductions are claimed for.

Information regarding the actual operation of the project activity

The biogas plant installation can be divided into 3 major components; *continuous-flow stirred tank reactor (CSTR), biogas boiler and open flare system.*

CSTR

The CSTR tanks have been installed and operating in good condition since the project commissioning date. The tanks have not undergone any change or modification since the project registration date. The project plant has installed 2 units of floating of roof tanks and 1 unit of fixed tank roof, each with a capacity of 2500 m^3.

Biogas boiler

The packaged boiler[4], located at the boiler house is fitted with a biogas burner[5]. The boiler operates daily, as it is the main boiler that supplies steam for process to the refinery. Additional steam for the refinery comes from the biomass boiler located in the neighboring palm oil mill and the medium fuel oil fired boilers. No modification has been made to the boiler since the project registration date.

Open-flare system

For the current monitoring period, flaring has only taken place during June 2009. All biogas produced from the site has been combusted in the boiler. Though not utilized frequently, the flare equipments are maintained in good operating condition. The efficiency of the flaring activity is fixed at 50%, due to it being an open-flare system. Nevertheless, as described in Section A.4 above, flaring efficiency is calculated as 0%.

---

[4] Marshall Boiler, model FS6000; serial number of 98127.

[5] Dunphy burner, model THD 530 ZML VP RT; serial number 21865. Minimum gas inlet pressure is at 1.3 psi.

The biogas plant is legally approved to be operated by the Department of Safety and Health. The approval was given on the 24th May 2007. On a periodic basis (at least once in 15 months), the biogas boiler will be subjected to inspection by the same department.

B.2. Revision of the monitoring plan

>>
Not applicable

B.3. Request for deviation applied to this monitoring period

Not applicable

B.4. Notification or request of approval of changes

>>
Not applicable

SECTION C. Description of the monitoring system

A total number of 27 parameters are monitored for this project activity. During the monitoring period (01/05/09 – 31/01/11), the data collection has been well managed and all records are in place. Most of the data are logged by SCADA software into a computer placed at the control room in the Unitata boiler house.

List of major equipments

Equipment	Capacity/specifications	Manufacturer/Constructor	Serial Number (if available)	Starting Date*
CSTR tanks (2 floating roof, 1 fixed roof, 1 sedimentation tank)	Floating / fixed roof – 2500m^3 each Sedimentation tank – 500m^3	Novaviro Technologies	Not applicable	1st January 2007
Flaring system	500 m^3/hr	Novaviro Technologies	Not applicable	1st January 2007
Burner	1800 – 9500 kW (gas)	Dunphy Combustion Ltd.	21865	1st January 2007
Boiler	17.5 bar g (250 psi) 10t/hr (21120 lbs/hr)	Marshalls Boiler	98127	Not applicable (Boiler has been in place prior to project activity)

****Prior to the starting date, the testing and commissioning was done between September 2006 and December 2006.***

List of monitoring equipments

Symbol	ID (as per PDD)	Parameter	Type	Make/Model	Serial Number	Primary Data Recording	Crosscheck Method
F_{dig}	Data#1	Flowrate of organic wastewater into the digester	Magnetic flowmeter	Siemens FM Magflo Mag 5100W (flowmeter) Siemens FM Magflo Mag 5000 (transmitter)	7ME651 553114T296 7ME6910-1AA30-1AA0 (Code No.)	SCADA	FFB processed data; POME:FFB ratio should be in the range of 0.44 – 1.18
$COD_{c,baseline}$	Data#2	COD concentration of organic wastewater into the digester	COD analysis kit	HACH DRB200/ DR890	Not available	External laboratory report	Internal (Unitata) laboratory report
$COD_{a,out}$	Data#3	COD concentration of the effluent that leaves the lagoon (Historical value)	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable
$COD_{a,in}$	Data#4	COD concentration of the effluent that enters the lagoon which is assumed to be equal to the COD input to the digester (Historical value)	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable

Symbol	ID (as per PDD)	Parameter	Type	Make/Model	Serial Number	Primary Data Recording	Crosscheck Method
T_{lag}	Data#5	Temperature of lagoon	Data obtained from Malaysian Meteorological Services (MMS)	Not Applicable	Not Applicable	MMS report	-
D_{lag}	Data#6	Depth of lagoon	Measuring pole	Not Applicable	Not Applicable	Logbook	-
$HG_{Bl,y}$	Data#9	Quantity of thermal energy that would be consumed in year y at the project site in the absence of the project activity using fossil fuel	Vortex flowmeter	Yokogawa / DY100	S5F606169-624	SCADA ($FR_{e,inlet}$)	SCADA (Tonnes of steam output)
h_{boiler}	Data#9a	Operating hours per year of the refinery boiler fired on biogas	Logsheet	Not Applicable	Not Applicable	Steam and hours log	-
$H_{refinery}$	Data#9b	Operating hours per year of the refinery using steam from biogas boiler	Logsheet	Not Applicable	Not Applicable	Logbook	-
F_{dig_out}	Data#10	Flow rate of organic wastewater from the digester	Magnetic flowmeter	Siemens Magflo 5100	7ME651 553114T296	SCADA	Same as F_{dig}

Symbol	ID (as per PDD)	Parameter	Type	Make/Model	Serial Number	Primary Data Recording	Crosscheck Method
COD_{c,dig_out}	Data#11	COD concentration in discharged effluent from digester	COD analysis kit	HACH DRB200/ DR890	Not available	External laboratory report	Internal (Unitata) laboratory report
$EL_{Pr,y}$	Data#12	Amount of electricity in the year y that is consumed at the project site for the project activity	kWh / electricity meter	Lenin-MPI	2005-2035807	Logbook	-
F_{la}	Data#14	Flow rate of sludge applied to land	Magnetic flowmeter	Endress Hauser Promag 10 (2 units)	8C0CC019000 / 87163719000	Logbook	-
$COD_{c,la}$	Data#15	COD concentrations in sludge used for land application	COD analysis kit	HACH DRB200/ DR890	Not available	External laboratory report	-
FR_{bio}	Data#18	Amount of biogas collected in the outlet of the bio-digester measured using a continuous flow meter	Vortex flowmeter	Endress Hauser/72W1FH-SEOAA1AAA4AA	85029120000	SCADA	-

Symbol	ID (as per PDD)	Parameter	Type	Make/Model	Serial Number	Primary Data Recording	Crosscheck Method
$P_{CH4,bio}$	Data#19	Percentage of biogas that is methane in the outlet of the bio-digester	Gas analyzer	GA 2000 gas monitor	GA10356	Analyser logsheet for digester plant	Analyser logsheet for boiler house
$FR_{f,inlet}$	Data#20	Flow rate of biogas entering the flare	Vortex flowmeter	Endress Hauser / 72F1H-SE0AA1AA4AA	8A026E20000	SCADA	-
$PE_{flare,y}$	Data#22	Project emissions from flaring of the residual gas stream in year 'y'	Calculated value			Not applicable	-
Flame detection	Data#22a	Detection of flame in the open flare being on	Thermocouple	Tempsens Instruments	Not available	SCADA	-
$FR_{e,inlet}$	Data#28	Flow rate of the biogas entering the heat generation equipment	Vortex flowmeter	Yokogawa DY100	S5F606169-624	SCADA	-
$FR_{e,s}$	Data#29	Flow rate of the heat generation equipment stack gases	Vortex flowmeter	Codel VCEM 5000	VCEM5000-0059 TRX1 VCEM5000-0059 TRX1	SCADA	-
$P_{CH4,e,s}$	Data#30	Methane content in stack gas of heat generation equipment	External laboratory analysis			External laboratory report	-

Symbol	ID (as per PDD)	Parameter	Type	Make/Model	Serial Number	Primary Data Recording	Crosscheck Method
$T_{comb,e}$	Data#31	Fraction of time gas is combusted in the heat generation equipment	Calculated value			-	-
S_o	Data#32	Amount of sludge applied to land	External laboratory analysis			External laboratory report	-
NC	Data#33	Nitrogen content in the sludge used for land application, for estimating N_2O	External laboratory analysis			External laboratory report	-
Regulations and incentives relevant to	Data#34	-	Monitored at renewal of crediting period			Not applicable	-
Physical leakage of digester tanks	Data#35	Detection of physical leakage of digester tanks	Checks for leakage from tanks, monitoring point joints and piping are carried out monthly by the project proponent			Internal leakage test reports	-

Data logging/recording

Please refer to the table above.

Calibration status

Symbol	Type	Instrument ID	Make/Model	Serial Number	Calibration Frequency (Months)	Calibration date(s)
F_{dig}	Magnetic flowmeter	F1	Siemens Magflo 5100	7ME651 553114T296	12	05/11/10, 06/11/09, 14/11/08
$HG_{Bl,y}$	Vortex flowmeter	F4	Yokogawa / DY100	S5F606169-624	12	05/11/10, 06/11/09, 14/11/08
F_{dig_out}	Magnetic flowmeter	F1	Siemens Magflo 5100	7ME651 553114T296	12	05/11/10, 06/11/09, 14/11/08
$EL_{Pr,y}$	kWh / electricity meter	E1	Lenin-MPI CA4-U672T	2005-2035807	12	15/10/10, 19/10/09, 15/12/08
F_{la}	Magnetic flowmeter	F7	Endress Hauser Promag 10 (2 units)	8C0CC019000 / 87163719000	12	05/11/10, 06/11/09, 14/11/08
FR_{bio}	Vortex flowmeter	F3	Endress Hauser/72W1FH-SEOAA1AAA4AA	85029120000	12	05/11/10, 06/11/09, 14/11/08

Symbol	Type	Instrument ID	Make/Model	Serial Number	Calibration Frequency (Months)	Calibration date(s)
$P_{CH4,bio}$	Gas analyzer	CH2	GA 2000 gas monitor	GA10356	12	28/04/10, 16/06/09, 30/07/08
$FR_{f,inlet}$	Vortex flowmeter	F2	Endress Hauser / 72F1H-SE0AA1AA4AA	8A026E20000	12	05/11/10, 06/11/09, 14/11/08
$FR_{e,inlet}$	Vortex flowmeter	F4	Yokogawa DY100	S5F606169-624	12	05/11/10, 06/11/09, 14/11/08
$FR_{e,s}$	Vortex flowmeter	F6	Codel VCEM 5000	VCEM5000-0059 TRX1 VCEM5000-0059 TRX2	24	21/09/10, 30/09/08

Crosscheck Status

The total volume of POME fed into the digesters was 194,604 m3 while the total FFB processed for the monitoring period was 266,436 tonnes. This would results in a *POME (m3): FFB (tonnes) ratio* of 0.73, which is within the industrial range of 0.44 – 1.18[6].

All COD results that are produced by the external accredited laboratory are always cross-checked against the internal Unitata laboratory. To-date, the difference in the total COD inflow and outflow values ($COD_{c,baseline}$ – COD_{c,dig_out}) produced by the external accredited laboratory have always been more conservative compared with the internal laboratory values. In addition, the main COD parameter results, $COD_{c,baseline}$ produced by the external accredited laboratory, have been more conservative compared with the internal laboratory values on a monthly basis. $COD_{c,la}$ results are only produced by the external accredited laboratory.

[6] Microbial Biopolymerization Production from Palm Oil Mill Effluent (POME), Universiti Teknologi Malaysia

For parameter $HG_{Bl,y,}$ the thermal energy that would have been consumed in the absence of project activity is calculated by using the methane input into the boiler (as specified in AM 0013 ver. 04), rather than using the steam generated values (as specified in PDD). The methane input results in a 138,400 GJ of energy for the monitoring period, compared to the steam input method, which results in 161,186 TJ of energy. Hence, the more conservative approach has been chosen.

As for the percentage of the methane in the outlet of the biodigester, $P_{CH4,bio}$ the parameter is measured at the biodigester plant. Nevertheless, in order to ensure the readings produced at the digester plant are verifiable, a separate set of methane percentage readings are obtained from the boiler house and compared as a cross check method.

Downtime/maintenance/inspection period of biogas plant or monitoring equipments

Throughout the monitoring period, the biogas operations of the biogas plant was halted only 2 times, for annual inspection by the Department of Safety and Health (DOSH) officers. The periods are 08th – 18th of June 2009 and 16th – 26th of March 2010.

In addition to the above, the flowmeter measuring the total biogas was relocated in the month of October 2009. The works were carried out to comply with the deviation request submitted during the previous round of verification.

AD factor

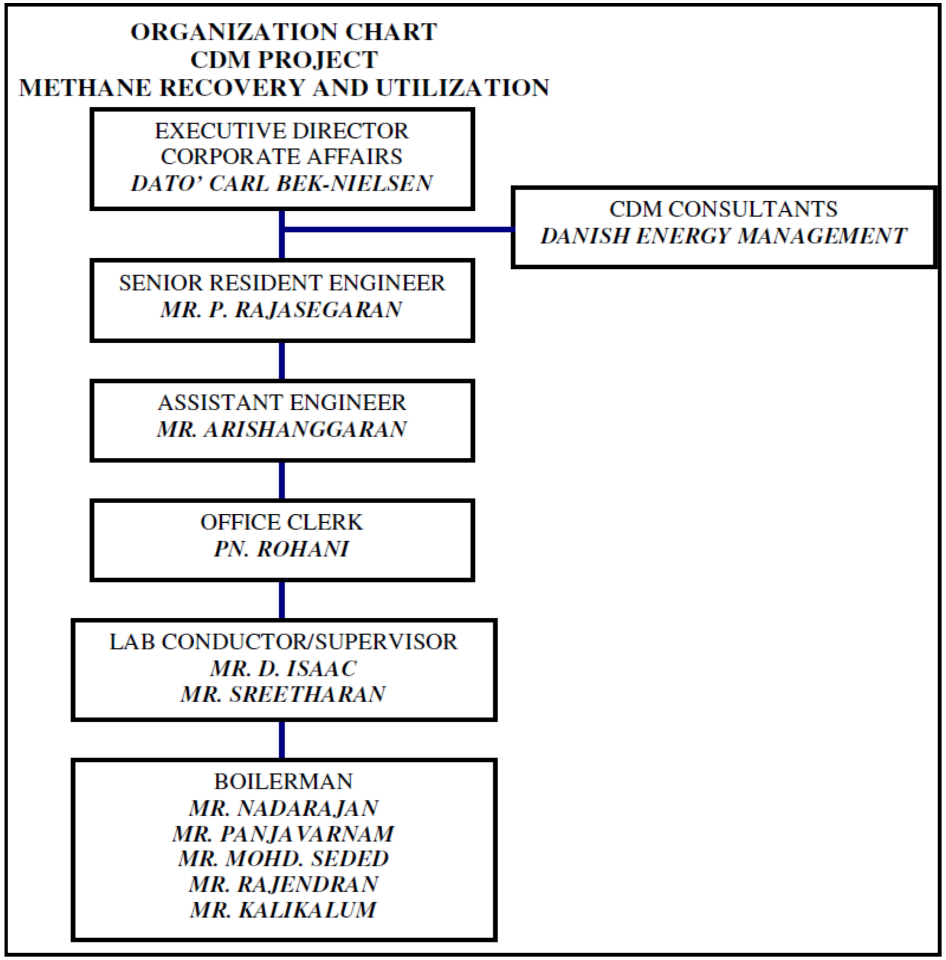
As per the PDD, under the monitoring plan, only 3 COD parameters are applicable during project implementation; $COD_{c,baseline}$, COD_{c,dig_out}, $COD_{c,la}$. The baseline COD parameters as per the PDD are $COD_{a,in}$ and $COD_{a,out}$. $COD_{a,in}$ and $COD_{a,out}$ values have been established at the point of PDD validation. The values to be applied for $COD_{a,out}$ and $COD_{a,in}$ calculation during project scenario are historical values. As per Annex 3 of the PDD, $COD_{a,in}$ and $COD_{a,out}$ values are 74.633kgCOD/m^3 and 2.941kgCOD/m^3 respectively. Nevertheless, the project proponent has conservatively applied a value of 52.00kgCOD/m^3 for the parameter $COD_{a,in}$ and 2.941kgCOD/m^3 for $COD_{a,out}$ during validation. Section B.6.3 of the PDD has calculated the AD factor to be at 0.9434. This approach is considered the most conservative and is in-line with the methodology and PDD.

COD conservative approaches

For the month of May 2010, the COD_{c,dig_out} result from external laboratory contained a reporting error. The value reported by the external accredited laboratory was 1.21kgCOD/m3, which is lower than the external lab value for $COD_{c,la}$ (land application); 3.54kgCOD/m3. The wastewater coming out of the digester tank is further treated by aerobic lagoons, before being sent for land application. This is considered as a reporting error and the value is not used for any calculations leading to the emission reductions. As a conservative measure, the average value of the entire internal Unitata lab results (11 results) for ST discharge for the month of May 2010 has been used to calculate the monthly value for COD_{c,dig_out}. The resulting value, which is 17.11kgCOD/m^3 is deemed conservative as it is lower than the average COD_{c,dig_out} results for the year 2010 (16.66kgCOD/m^3).

For the month of January 2011, the external accredited lab reported $COD_{c,la}$ as 22.055 kg/m^3. If the value reported by the external laboratory is applied, it will result in negative project emissions from lagoon. Hence, for project emissions from lagoon calculations, $COD_{c,la}$ is equivalent to '0'. This approach is considered most conservative. Nevertheless, for the calculation of project emissions from land application, the value of 22.055 kg/m^3 is used.

Organization Chart and Roles and Responsibilities



Name	Designation	Roles and Responsibilities
Dato' Carl Bek-Nielsen	Executive Director	CDM Advisor - Corporate
Mr. Vincent Williams	Group Engineer (Jendarata)	CDM Advisor - Operations
Mr. P. Rajasegaran	Senior Resident Engineer	CDM Manager • Verifies all inputs from monitoring parameters • CER calculation • Liaison with third party CDM consultants • Conducts internal review/audits to cross check CDM data
Mr. Arishanggaran	Assistant Engineer	CDM Assistant • Assist the CDM Manager • Receives inputs from monitoring points • Cross check all CDM data • Compiles all raw data
Pn. Rohani	Office Clerk	Data Entry • Keys in raw data received from Lab Conductor/Supervisor into an excel spreadsheet on daily basis
Mr. D. Isaac Mr. Sreetharan	Lab Conductor Supervisor	Raw Data Log • Obtains raw data input from the meters installed on daily basis
Mr. Nadarajah Mr. Panjavarnam Mr. Rajendran Mr. Mohd. Seded Mr. Kalikalum	Boilerman	Boiler Operation (Refer Standard Operating Procedure for Biogas Boiler)

As per the roles and responsibility table above, the responsibility of the project management is held by the Jendarata Engineering Department, headed by the Senior Resident Engineer (SRE). The SRE acts as the CDM Manager for the project, assisted by the department's assistant

engineer. The table above lists all the responsibility of the key personnel involved. The CDM Consultants, Danish Energy Management, is the responsible for the monitoring of the project and generate the monitoring reports (MR).

Quality control process

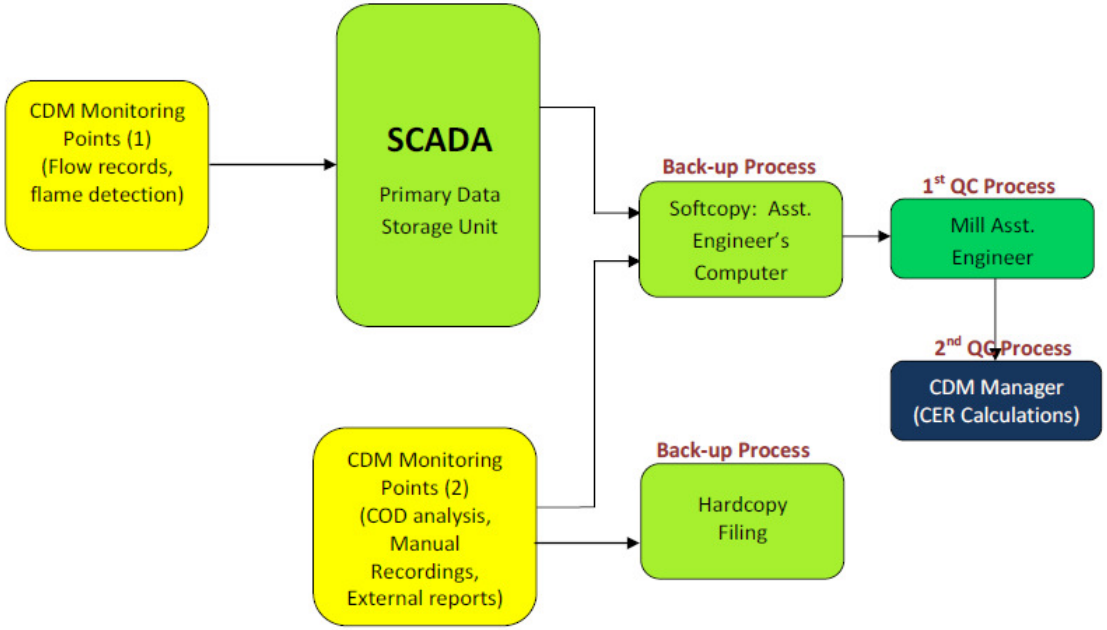


Figure 2: Communication Process on transfer of data at site

The data collected at the project site is transferred as per diagram above. The first set of CDM monitoring records, flow (POME flow, gas flow, steam flow, etc) and flame detection will be logged into the SCADA electronically. The SCADA system's data storage unit is located at the Unitata's refinery boiler house. The data will be transferred into an excel sheet for CER calculation (raw data file). The data or results on the second set of CDM monitoring records (analysis reports, manual recordings, etc), which are received as hardcopy, will be transferred into the same excel sheet for CER calculation. The hardcopy reports will be filed accordingly.

The 1st QC process takes place when the mill's assistant engineer, Mr. Arish receives all records from SCADA and external reports, prior to consolidating all data. The 2nd QC process takes place when the CDM Manager, receives the raw data file from the mill's assistant engineer. The CDM Manager will check through the data keyed into the raw data file before using them to compute the CER calculations.

SECTION D. Data and parameters

D.1. Data and parameters determined at registration and not monitored during the monitoring period, including default values and factors

Data / Parameter:	Palm Oil Mill Operating Capacity
Data unit:	t FFB/hr (or per day, per month, per year)
Description:	The mill capacity is represented by tonnage of fresh fruit bunch (FFB) processed per unit time.
Source of data used:	Mill owner
Value(s) :	45 t/hr, 600 t/day
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	For baseline emission calculation
Additional comment:	This is the maximum operating capacity for the mill. The value may be used for estimation of POME flow, accumulating over a year, according to the operating daily operating hours of the mill.

Data / Parameter:	Operating days per year
Data unit:	Days/year
Description:	This represents the number of days the mill is operating in a year.
Source of data used:	Mill operator.
Value(s) :	300 days/year
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	For baseline and project emission calculation
Additional comment:	-

Data / Parameter:	T_2
Data unit:	deg C
Description:	Ambient temperature based on monthly maximum, minimum and average temperature at or near project site.
Source of data used:	Malaysian Meteorological Services (MMS) Department.
Value(s) :	27.3 deg C (average); 23.6 deg C (min) and 32.5 deg C (max).
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	For baseline emission calculation
Additional comment:	-

Data / Parameter:	B_o
Data unit:	kg CH_4/kg COD
Description:	Maximum methane production potential.
Source of data used:	IPCC
Value(s) :	0.21 kg CH_4/kg COD / 0.25 kg CH_4/kg COD
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	For baseline and project emission calculation
Additional comment:	The default IPCC value for B_o is 0.25 kg CH_4/kg COD. Taking into account the uncertainty of this estimate, the project participant uses a value of 0.21 kg CH_4/kg COD as a conservative assumption for B_o, in accordance with the requirement of AM0013, Version 04, page 8. Nevertheless, as per the PDD (page 34), the applied value for B_o to calculate PE_{CH4_leak} is 0.25 kg CH_4/kg COD; a conservative approach in calculating project emissions.

Data / Parameter:	f_d
Data unit:	Fraction number
Description:	Fraction of anaerobic degradation due to depth
Source of data used:	AM0013 Version 4
Value(s) :	0.50
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	For baseline emission calculation
Additional comment:	-
Data / Parameter:	$CEF_{Bl,therm}$
Data unit:	t CO_2eq/TJ
Description:	CO_2 emissions intensity for thermal energy generation.
Source of data used:	IPCC
Value(s) :	75.5
Indicate what the data are	For baseline emission calculation

used for (Baseline/ Project/ Leakage emission calculations)	
Additional comment:	-

Data / Parameter:	EF_{N2O}
Data unit:	kg N_2O/kg N
Description:	Emission factor of nitrogen from sludge applied to land.
Source of data used:	As recommended in AM0013.
Value(s) :	0.016 kg N_2O/kg N
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	For project emission calculation
Additional comment:	-

D.2.	**Data and parameters monitored**

Data / Parameter:	F_{dig}
Data unit:	m^3/month
Description:	Flow rate of organic wastewater into the digester.
Measured /Calculated /Default:	Measured
Source of data:	Measured by magnetic flowmeter with a totalizer
Value(s) of monitored parameter:	194,604 m^3 (01/05/09 – 31/01/11)
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	For baseline emission calculation
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Type: Magnetic Flowmeter Make/Model: Siemens / MagFlo Mag 5100W Accuracy class: IP67 Serial no: 7ME651 553114T296 Calibration frequency: Annual Date of initial calibration: 14/11/08 Date of 2nd calibration: 06/11/09 Date of last calibration: 05/11/10 Validity: 1 year
Measuring/ Reading/ Recording frequency:	Hourly
Calculation method (if applicable):	Not applicable
QA/QC procedures applied:	Flowmeter is subjected to annual calibration by certified calibration company.

Data / Parameter:	$COD_{c,baseline}$
Data unit:	kg/m^3
Description:	COD concentration of organic wastewater into the digester.
Measured /Calculated /Default:	Measured
Source of data:	COD analysis report (internal and external)
Value(s) of monitored parameter:	76.76 kg/m^3 (average of 01/05/09 – 31/01/11)
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	For baseline emission calculation
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Type: COD analysis kit Make/Model: HACH DRB200 / HACH DR890 Accuracy class: Not applicable Serial no: Not available Calibration frequency: Not applicable

	Date of last calibration: Not applicable Validity: Not applicable
Measuring/ Reading/ Recording frequency:	Monthly
Calculation method (if applicable):	Not applicable
QA/QC procedures applied:	COD tests are carried out by laboratory accredited by ISO 17025 and SAMM (Accreditation Certificate of Malaysian Laboratory). For cross-check purposes, internal COD tests carried out by the Unitata Laboratory is used.

Data / Parameter:	$COD_{a,out}$
Data unit:	kg/m^3
Description:	COD concentration of the effluent that leaves the lagoon.
Measured /Calculated /Default:	Measured
Source of data:	COD analysis report
Value(s) of monitored parameter:	2.941 kg/m^3 (Historical value)
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	For baseline emission calculation. Used in determining the AD factor to be applied in BE_{lagoon} calculation.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Type: Not Applicable Make/Model: Not Applicable Accuracy class: Not Applicable Serial no: Not Applicable Calibration frequency: Not applicable Date of last calibration: Not applicable Validity: Not applicable
Measuring/ Reading/ Recording frequency:	Historical value
Calculation method (if applicable):	Not applicable
QA/QC procedures applied:	Not applicable

Data / Parameter:	$COD_{a,in}$
Data unit:	kg/m^3
Description:	COD concentration of the effluent that enters the lagoon which is assumed to be equal to the COD input to the digester.
Measured /Calculated /Default:	Measured
Source of data:	COD analysis report
Value(s) of monitored parameter:	52.00 kg/m^3 (Historical value)
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	For baseline emission calculation. Used in determining the AD factor to be applied in BE_{lagoon} calculation.

Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Type: Not Applicable Make/Model: Not Applicable Accuracy class: Not Applicable Serial no: Not Applicable Calibration frequency: Not applicable Date of last calibration: Not applicable Validity: Not applicable
Measuring/ Reading/ Recording frequency:	Historical value
Calculation method (if applicable):	Not applicable
QA/QC procedures applied:	Not applicable

Data / Parameter:	T_{lag}
Data unit:	Degree C (to be converted to deg K)
Description:	To be obtained from the Malaysian Meteorology Services (MMS) Department network of ambient temperature monitoring. The ambient temperature data for a network site nearest to the project site will be used.
Measured /Calculated /Default:	Measured
Source of data:	Malaysian Meteorology Services (MMS) Department
Value(s) of monitored parameter:	27.5 ºC (average of 01/05/09 – 31/01/11)
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	For baseline emission calculation
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Type: Not applicable (Data is obtained from MMS department) Make/Model: Not applicable Accuracy class: Not applicable Serial no: Not applicable Calibration frequency: Not applicable Date of last calibration: Not applicable Validity: Not applicable
Measuring/ Reading/ Recording frequency:	Daily
Calculation method (if applicable):	Not applicable
QA/QC procedures applied:	MMS is following international standard methods in its monitoring programmes.

Data / Parameter:	D_{lag}
Data unit:	m (metre)
Description:	Depth of lagoon.
Measured /Calculated /Default:	Measured
Source of data:	Measured by depth measurement pole(s)
Value(s) of monitored	2 m (average of 01/05/09 – 31/01/11)

parameter:	
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	For project emission calculation
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Type: Depth measurement pole Make/Model: Not applicable Accuracy class: Not applicable Serial no: Not applicable Calibration frequency: Not applicable Date of last calibration: Not applicable Validity: Not applicable
Measuring/ Reading/ Recording frequency:	Daily
Calculation method (if applicable):	Not applicable
QA/QC procedures applied:	Depth of lagoon is monitored daily using a depth measuring pole.

Data / Parameter:	$HG_{Bl,y}$
Data unit:	MJ/yr
Description:	Quantity of thermal energy that would be consumed in year y at the project site in the absence of the project activity using fossil fuel.
Measured /Calculated /Default:	Measured (methane input) and calculated (thermal energy)
Source of data:	Measured by vortex flowmeter
Value(s) of monitored parameter:	138,400,446 MJ (01/05/09 – 31/01/11)
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	For baseline emission calculation
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Type: Vortex flowmeter Make/Model: Yokogawa / DY100 Accuracy class: IP 68 Serial no: S5F606169-624 Calibration frequency: Annual Date of 1st calibration: 14/11/08 Date of 2nd calibration: 06/11/09 Date of last calibration: 05/11/10 Validity: 1 year
Measuring/ Reading/ Recording frequency:	Hourly
Calculation method (if applicable):	Monitored biogas flow is multiplied with methane percentage ($P_{CH4,bio}$) and calorific value of methane, to derive amount of thermal energy, $HG_{Bl,y}$
QA/QC procedures applied:	Flowmeter is subjected to annual calibration by certified calibration company.

Data / Parameter:	h_{boiler}

Data unit:	h/yr
Description:	Operating hours per year of the refinery boiler fired on biogas.
Measured /Calculated /Default:	Measured
Source of data:	Boiler operating hour records
Value(s) of monitored parameter:	14,856 h (01/05/09 – 31/01/11)
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Not applicable; only for cross-checking on boiler's biogas consumption and steam generation
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Type: Manual logsheet records Make/Model: Not applicable Accuracy class: Not applicable Serial no: Not applicable Calibration frequency: Not applicable Date of last calibration: Not applicable Validity: Not applicable
Measuring/ Reading/ Recording frequency:	Daily
Calculation method (if applicable):	Total hours in a year deducted with maintenance period of 22 days
QA/QC procedures applied:	Maintenance period of boiler (08^{th} 18^{th} June 2009, 16^{th} -26^{th} March 2010) has been taken into consideration.

Data / Parameter:	$H_{refinery}$
Data unit:	h/yr
Description:	Operating hours per year of the refinery using steam from biogas boiler.
Measured /Calculated /Default:	Measured
Source of data:	Refinery operating hour records
Value(s) of monitored parameter:	15,384 h (01/05/09 – 31/01/11)
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Not applicable; only for cross-checking on refinery's consumption of steam from biogas boiler.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Type: Manual logsheet records Make/Model: Not applicable Accuracy class: Not applicable Serial no: Not applicable Calibration frequency: Not applicable Date of last calibration: Not applicable Validity: Not applicable
Measuring/ Reading/ Recording frequency:	Daily
Calculation method (if applicable):	-

QA/QC procedures applied:	-

Data / Parameter:	F_{dig_out}
Data unit:	m^3/month
Description:	Flow rate of organic wastewater from the digester.
Measured /Calculated /Default:	Measured
Source of data:	Measured by magnetic flowmeter with a totalizer (same unit as F_{dig})
Value(s) of monitored parameter:	194,604 m^3 (01/05/09 – 31/01/11)
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	For project emission calculation
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Type: Magnetic Flowmeter Make/Model: Siemens / Mag 5100W Accuracy class: IP67 Serial no: 7ME651 553114T296 Calibration frequency: Annual Date of initial calibration: 14/11/08 Date of 2nd calibration: 06/11/09 Date of last calibration: 05/11/10 Validity: 1 year
Measuring/ Reading/ Recording frequency:	Hourly
Calculation method (if applicable):	Not applicable
QA/QC procedures applied:	The flowmeter for F_{dig} and F_{dig_out} are the same unit. This is based on assumption that all POME influent into the digester equals to POME effluent out of the digester. Flowmeter is subjected to annual calibration by certified calibration company.

Data / Parameter:	COD_{c,dig_out}
Data unit:	kg/m^3
Description:	COD concentration in discharged effluent from digester.
Measured /Calculated /Default:	Measured
Source of data:	COD analysis report (internal and external)
Value(s) of monitored parameter:	17.74 kg/m^3 (average of 01/05/09 – 31/01/11)
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	For project emission calculation
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last	Type: COD analysis kit Make/Model: HACH DRB200 / HACH DR890 Accuracy class: Not applicable Serial no: Not available

calibration, validity)	Calibration frequency: Not applicable Date of last calibration: Not applicable Validity: Not applicable
Measuring/ Reading/ Recording frequency:	Monthly
Calculation method (if applicable):	Not applicable
QA/QC procedures applied:	External COD tests are carried out by laboratory accredited by ISO 17025 and SAMM (Accreditation Certificate of Malaysian Laboratory). For cross-check purposes, internal COD tests carried out by the Unitata Laboratory is used.

Data / Parameter:	$EL_{Pr,y}$
Data unit:	MWh/yr
Description:	Amount of electricity in the year y that is consumed at the project site for the project activity.
Measured /Calculated /Default:	Measured
Source of data:	Measured by a kWh or electricity meter
Value(s) of monitored parameter:	865,631 kWh (01/05/09 – 31/01/11)
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	For project emission calculation
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Type: kWh/electricity meter Make/Model: MPI Lenin / CA4-U672T Accuracy class: Class 2 Serial no: 2005-2035807 Calibration frequency: Annual Date of initial calibration: 15/12/08 Date of 2nd calibration: 19/10/09 Date of last calibration: 15/10/10 Validity: 1 year
Measuring/ Reading/ Recording frequency:	Daily
Calculation method (if applicable):	Not applicable
QA/QC procedures applied:	kWh meter is subjected to annual calibration by certified personnel (Energy Commission of Malaysia) and calibration company

Data / Parameter:	F_{la}
Data unit:	m^3/yr
Description:	Flow rate of sludge applied to land.
Measured /Calculated /Default:	Measured
Source of data:	Measured by 2 units of magnetic flowmeter
Value(s) of monitored parameter:	132,744 m^3 (01/05/09 – 31/01/11)

Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	For project emission calculation
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Type: Magnetic flowmeter Make/Model: Endress Hauser / Promag 10 Accuracy class: IP 68 Serial no: 8C0CC019000 / 87163719000 Calibration frequency: Annual Date of initial calibration: 14/11/08 Date of 2nd calibration: 06/11/09 Date of last calibration: 05/11/10 Validity: 1 year
Measuring/ Reading/ Recording frequency:	Daily
Calculation method (if applicable):	Not applicable
QA/QC procedures applied:	Flowmeter is subjected to annual calibration by certified calibration company.

Data / Parameter:	$COD_{c,la}$
Data unit:	kg/m^3
Description:	COD concentrations in sludge used for land application.
Measured /Calculated /Default:	Measured
Source of data:	COD analysis report (internal and external)
Value(s) of monitored parameter:	4.50 kg/m^3 (average of 01/05/09 – 31/01/11)
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	For project emission calculation
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Type: COD analysis kit Make/Model: HACH DRB200 / HACH DR890 Accuracy class: Not applicable Serial no: Not available Calibration frequency: Not applicable Date of last calibration: Not applicable Validity: Not applicable
Measuring/ Reading/ Recording frequency:	Monthly
Calculation method (if applicable):	Not applicable
QA/QC procedures applied:	External COD tests are carried out by laboratory accredited by ISO 17025 and SAMM (Accreditation Certificate of Malaysian Laboratory).

Data / Parameter:	FR_{bio}
Data unit:	m^3/yr

Description:	Amount of biogas collected in the outlet of the Bio-digester measured using a continuous flow meter.
Measured /Calculated /Default:	Measured
Source of data:	Measured by vortex flowmeter
Value(s) of monitored parameter:	7,777,921 Nm^3 (01/05/09 – 31/01/11)
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	For baseline emission calculation
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Type: Vortex flowmeter Make/Model: Endress Hauser / Prowirl 72 Accuracy class: IP 68 Serial no: 85029120000 Calibration frequency: Annual Date of initial calibration: 14/11/08 Date of 2nd calibration: 06/11/09 Date of last calibration: 05/11/10 Validity: 1 year
Measuring/ Reading/ Recording frequency:	Hourly
Calculation method (if applicable):	Not applicable
QA/QC procedures applied:	Flowmeter is subjected to annual calibration by certified calibration company. The deviation request from previous verification covers until the period November 2009. For the current monitoring period, FRbio is calculated as $FR_{e,inlet} + FR_{f,inlet}$ from May – Oct 2009. The relocation of the flowmeter to measure FR_{bio} was completed in October 2009.

Data / Parameter:	$P_{CH4,bio}$
Data unit:	%
Description:	Percentage of biogas that is methane in the outlet of the bio-digester
Measured /Calculated /Default:	Measured
Source of data:	Measured by gas analyser
Value(s) of monitored parameter:	58.68% (average of 01/05/09 – 31/01/11)
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	For baseline and project emission calculation
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Type: Gas analyser Make/Model: Geotechnical Instruments/GA 2000 Accuracy class: IP 68 Serial no: GA10356 Calibration frequency: Annual Date of initial calibration: 30/07/08

	Date of 2nd calibration: 16/06/09 Date of last calibration: 28/04/10 Validity: 1 year
Measuring/ Reading/ Recording frequency:	Monthly (7 readings a month)
Calculation method (if applicable):	Not applicable
QA/QC procedures applied:	Gas analyser is subjected to annual calibration by certified calibration company. As a cross-check, sampling and anlysis will also be conducted at the biogas boiler house. All sampling/analysis of the biogas is done on wet basis.

Data / Parameter:	$FR_{f,inlet}$
Data unit:	m^3/yr
Description:	Flow rate of biogas entering the flare
Measured /Calculated /Default:	Measured
Source of data:	Measured by a vortex flowmeter
Value(s) of monitored parameter:	29,360 Nm^3 (01/05/09 – 31/01/11)
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	For project emission calculation
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Type: Vortex flowmeter Make/Model: Endress Hauser / Prowirl 72 Accuracy class: IP 68 Serial no: 8A026E20000 Calibration frequency: Annual Date of initial calibration: 14/11/08 Date of 2nd calibration: 06/11/09 Date of last calibration: 05/11/10 Validity: 1 year
Measuring/ Reading/ Recording frequency:	Hourly
Calculation method (if applicable):	Not applicable
QA/QC procedures applied:	Flowmeter is subjected to annual calibration by certified calibration company.

Data / Parameter:	$PE_{flare,y}$
Data unit:	tCO_{2eq}/yr
Description:	Project emissions from flaring of the residual gas stream in year y (**$PE_{flare,y}$**)
Measured /Calculated /Default:	Calculated
Source of data:	Measurements from $FR_{f,inlet}$ and $PCH_{4,bio}$
Value(s) of monitored parameter:	441.46tCO_{2eq} (01/05/09 – 31/01/11)

Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	For project emission calculation
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Type: Not applicable (Calculated value) Make/Model: Not applicable Accuracy class: Not applicable Serial no: Not applicable Calibration frequency: Not applicable Date of last calibration: Not applicable Validity: Not applicable
Measuring/ Reading/ Recording frequency:	Monthly
Calculation method (if applicable):	Calculation is based on Step 1 to Step 7 of the '*'Tool to determine project emissions from flaring gases containing methane*''
QA/QC procedures applied:	-

Data / Parameter:	Flame Detection
Data unit:	On/off
Description:	Detection of flame in the open flare being on or off.
Measured /Calculated /Default:	Measured
Source of data:	Measured by thermocouple in the flare system
Value(s) of monitored parameter:	Not applicable (values are 'on' or 'off')
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	For project emission calculation
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Type: Thermocouple Make/Model: Tempsens Instruments Accuracy class: Not applicable Serial no: Not applicable Calibration frequency: Not applicable Date of last calibration: Not applicable Validity: Not applicable
Measuring/ Reading/ Recording frequency:	Continuous
Calculation method (if applicable):	Not applicable
QA/QC procedures applied:	-

Data / Parameter:	$FR_{e,inlet}$
Data unit:	m^3/yr
Description:	Flow rate of the biogas entering the heat generation equipment
Measured /Calculated /Default:	Measured
Source of data:	Measured by a vortex flowmeter
Value(s) of monitored	7,748,561 Nm^3 (01/05/09 – 31/01/11)

parameter:	
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	For baseline emission calculation
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Type: Vortex flowmeter Make/Model: Yokogawa / DY100 Accuracy class: IP 68 Serial no: S5F606169-624 Calibration frequency: Annual Date of initial calibration: 14/11/08 Date of 2nd calibration: 06/11/09 Date of last calibration: 05/11/10 Validity: 1 year
Measuring/ Reading/ Recording frequency:	Hourly
Calculation method (if applicable):	Two methods used at site to measure the biogas flow into the boiler; a) Directly monitored using a flowmeter at the biogas boiler house b) The total gas out of digester (FR_{bio}) is deducted with gas flared ($FR_{f,inlet}$); cross-check method The more conservative of the two above is applied for emission reductions calculations.
QA/QC procedures applied:	Flowmeter is subjected to annual calibration by certified calibration company.

Data / Parameter:	$FR_{e,s}$
Data unit:	m^3/yr
Description:	Flow rate of the heat generation equipment stack gases
Measured /Calculated /Default:	Measured
Source of data:	Measured by a vortex flowmeter
Value(s) of monitored parameter:	167,813,673 Nm^3 (01/05/09 – 31/01/11)
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	For baseline emission calculation
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Type: Infrared Correlation Make/Model: Codel / VCEM 5000 series Accuracy class: IP 66 Serial no: VCEM5000-0059TRX1 / VCEM5000-0059TRX2 Calibration frequency: Once in 2 years Date of initial calibration: 30/09/08 Date of last calibration: 21/09/10 Validity: 2 years
Measuring/ Reading/ Recording frequency:	Hourly
Calculation method (if	Not applicable

applicable):	
QA/QC procedures applied:	Flowmeter is subjected to calibration once in two years by certified calibration company.

Data / Parameter:	$P_{CH4,e,s}$
Data unit:	%
Description:	Methane content in stack gas of heat generation equipment
Measured /Calculated /Default:	Measured
Source of data:	Measurements are conducted by external accredited laboratory, on a quarterly basis
Value(s) of monitored parameter:	0.01% (average of 01/05/09 – 31/01/11)
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	For project emission calculation
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Type: Not applicable (measurements conducted by external laboratory) Make/Model: Not applicable Accuracy class: Not applicable Serial no: Not applicable Calibration frequency: Not applicable Date of last calibration: Not applicable Validity: Not applicable
Measuring/ Reading/ Recording frequency:	Quarterly analysis
Calculation method (if applicable):	Not applicable
QA/QC procedures applied:	External sampling and analysis is conducted by 3rd party laboratory certified with ISO 17025 and SAMM. No methane is detected in the stack gas from boiler for the monitoring period. Applied value is the detection limit of the analysis unit.

Data / Parameter:	$T_{comb,e}$
Data unit:	Fraction/ratio
Description:	Fraction of time gas is combusted in the heat generation equipment
Measured /Calculated /Default:	Calculated
Source of data:	Data calculated based on run time meter connected to the flame detector in the boiler
Value(s) of monitored parameter:	0.86 (01/05/09 – 31/01/11)
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Not applicable (as a cross checking tool against biogas combustion rate against total hours in a year)
Monitoring equipment (type, accuracy class, serial	Type: Not applicable (calculated value) Make/Model: Not applicable

number, calibration frequency, date of last calibration, validity)	Accuracy class: Not applicable Serial no: Not applicable Calibration frequency: Not applicable Date of last calibration: Not applicable Validity: Not applicable
Measuring/ Reading/ Recording frequency:	Monthly
Calculation method (if applicable):	The duration of biogas combustion hours from the 'BURNER.csv' files will be added and divided against total hours in the monitoring period.
QA/QC procedures applied:	-

Data / Parameter:	S_o
Data unit:	Kg/yr
Description:	Amount of sludge applied to land
Measured /Calculated /Default:	Measured
Source of data:	Analysis are conducted by external accredited laboratory, on a monthly basis
Value(s) of monitored parameter:	173,025 kg (01/05/09 – 31/01/11)
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	For project emission calculation
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Type: Not applicable (analysis conducted by external laboratory) Make/Model: Not applicable Accuracy class: Not applicable Serial no: Not applicable Calibration frequency: Not applicable Date of last calibration: Not applicable Validity: Not applicable
Measuring/ Reading/ Recording frequency:	Monthly
Calculation method (if applicable):	Sludge concentration results from the lab are multiplied with flow of effluent to land application.
QA/QC procedures applied:	External sampling and analysis is conducted by 3rd party laboratory certified with ISO 17025 and SAMM.

Data / Parameter:	NC
Data unit:	kg N / kg sludge
Description:	Nitrogen content in the sludge used for land application, for estimating N_2O emission in project emission.
Measured /Calculated /Default:	Measured
Source of data:	Analysis are conducted by external accredited laboratory, on a monthly basis
Value(s) of monitored parameter:	0.0023 kgN/kg sludge (average of 01/05/09 – 31/01/11)

Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	For project emission calculation
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Type: Not applicable (analysis conducted by external laboratory) Make/Model: Not applicable Accuracy class: Not applicable Serial no: Not applicable Calibration frequency: Not applicable Date of last calibration: Not applicable Validity: Not applicable
Measuring/ Reading/ Recording frequency:	Monthly
Calculation method (if applicable):	Not applicable
QA/QC procedures applied:	External sampling and analysis is conducted by 3rd party laboratory certified with ISO 17025 and SAMM.

Data / Parameter:	Regulations and incentives relevant to effluent
Data unit:	-
Description:	-
Measured /Calculated /Default:	Measured
Source of data:	Malaysian Government publications
Value(s) of monitored parameter:	Not applicable (parameter monitored at renewal of crediting period)
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	For project baseline
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Not applicable
Measuring/ Reading/ Recording frequency:	At renewal of crediting period
Calculation method (if applicable):	Not applicable
QA/QC procedures applied:	Quality control for the existence and enforcement of relevant regulations and incentives is beyond bounds of the project activity. Instead, the DOE will verify the evidence collected.

Data / Parameter:	Physical leakage of digester tanks
Data unit:	Yes/no
Description:	Detection of physical leakage of digester tanks.
Measured /Calculated /Default:	Measured (manual soap test and observation for leakage checks)
Source of data:	Leakage test reports

Value(s) of monitored parameter:	Not applicable (measurements are only to determine whether leakage is evident or not)
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	For project emission calculations
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Type: Not applicable Make/Model: Not applicable Accuracy class: Not applicable Serial no: Not applicable Calibration frequency: Not applicable Date of last calibration: Not applicable Validity: Not applicable
Measuring/ Reading/ Recording frequency:	Bi-Monthly (two tests; one in each half of the month)
Calculation method (if applicable):	Not applicable
QA/QC procedures applied:	Data uncertainty level will be low. The monitoring work will be verified by assistant engineer.

SECTION E. Emission reductions calculation

Raw data for baseline and project emission calculations

Input data for baseline and project emission calculations – 'Data Input' sheet of UP Biogas CER Calculation file

	Data #5	Data #4(#2)	Data #15	Data #11(#3)	Data #1	Data #28	Data #18	Data #19	Data #14
Month	Ambient Temperature	$COD_{c,baseline}$	$COD_{c,la}$	COD_{c,dig_out}	Feed to AD tanks	Biogas consumed in boiler	Amount of Biogas out of digester	% of Methane in biogas consumed	Vol. Effluent for land application
	^{o}C	kg/m^3	kg/m^3	kg/m^3	m^3	Nm^3	Nm^3	%	m^3
May-09	28.0	74.87	2.67	16.82	10,485	410,033	410,033	55.35	2,550
Jun-09	28.3	99.66	3.13	19.93	7,265	212,960	242,320	57.79	4,085
Jul-09	27.4	73.04	3.84	13.36	9,094	354,208	354,208	61.9	5,288
Aug-09	27.2	106.67	3.77	25.03	8,208	371,239	371,239	57.91	4,557
Sep-09	27.3	78.62	3.31	21.52	8,530	388,408	388,408	57.91	4,447
Oct-09	27.2	108.91	3.67	21.78	6,855	444,387	444,387	57.06	5,408
Nov-09	26.8	39.31	2.94	21.93	10,569	447,101	418,347	58.44	7,642
Dec-09	27.0	72.60	3.10	19.77	11,132	460,547	425,956	59.08	6,565
Jan 2010	27.0	77.22	3.67	16.28	10,177	428,621	402,686	61.54	7,533
Feb-10	28.2	78.26	3.84	16.70	6,912	306,485	287,830	58.62	7,855
Mar-10	28.3	90.00	3.39	21.52	7,006	300,925	278,447	58.19	5,386
Apr-10	28.5	76.17	3.63	22.96	8,356	389,460	366,132	59.07	5,827
May-10	28.7	55.28	3.54	17.11	8,043	316,736	299,215	57.03	8,685
Jun-10	28.0	67.49	3.89	9.93	10,092	395,823	368,500	59.4	8,428
Jul-10	27.6	72.00	3.32	15.20	10,152	386,049	362,341	59.81	7,995
Aug-10	28.0	50.25	3.22	18.89	10,060	388,043	363,721	57.86	5,406

Sep-10	27.5	78.00	5.12	17.20	11,662	469,722	430,769	59.47	4,476
Oct-10	28.0	76.19	4.01	15.24	11,065	488,082	447,338	58.49	7,218
Nov-10	27.0	69.83	4.39	11.57	10,042	414,481	384,071	58.84	6,715
Dec-10	26.1	78.39	4.10	17.29	10,346	443,251	412,498	59.52	8,029
Jan-11	26.1	89.22	22.055	12.43	8,553	320,613	319,475	58.97	8,649

Month	**Data #20**			**Data #12**		**Data #33**
	Biogas flared	**No of operational days in a month**	**Power supply from biomass boiler**	**Power consumed a biogas plant**	**Concentration of sludge solid applied to land**	**NC**
	Nm^3	**days/mth**	**hrs/mth**	**kWh/mth**	**kg/m^3**	**kg N/kg sludge**
May-09	0	31	490	41,036.0	1.42	0.0023
Jun-09	29,360	30	462	41,348.0	0.58	0.0023
Jul-09	0	31	330	42,764.4	0.83	0.0023
Aug-09	0	31	543	42,432.4	1.64	0.0023
Sep-09	0	30	576	41,460.0	0.96	0.0026
Oct-09	0	31	585	43,212.4	1.53	0.0023
Nov-09	0	30	504	42,060.0	1.01	0.0022
Dec-09	0	31	450	43,624.4	0.87	0.0021
Jan 2010	0	31	166	42,864.4	0.71	0.0023
Feb-10	0	28	122	35,091.2	1.64	0.0022
Mar-10	0	31	293	37,384.4	1.09	0.0025
Apr-10	0	30	272	41,448.0	0.78	0.0029
May-10	0	31	274	41,484.4	0.91	0.0025
Jun-10	0	30	377	41,724.0	0.56	0.0023
Jul-10	0	31	471	40,067.6	1.25	0.0022
Aug-10	0	31	424	41,500.4	2.63	0.0020

Sep-10	0	30	422	41,428.0	2.16	0.0021
Oct-10	0	31	378	42,024.4	2.05	0.0021
Nov-10	0	30	331	40,468.0	1.78	0.0021
Dec-10	0	31	283	41,156.4	1.49	0.0020
Jan-11	0	31	121	41,052.4	1.79	0.0021

Month	**Data #22**	**Data #29**	**Data #30**		
	***PE_{flare}**	**Flow rate of boiler stack gas**	**CH_4 content in stack gas (quarterly)**	**Steam output**	**Steam enthalpy**
	t CO_{2eq}/mth	**Nm^3/mth**	**%**	**t/mth**	**kJ/kg**
May-09	0	9,319,430	0.01	2,941	2778.9
Jun-09	441.46	5,168,498	0.01	1,579	2778.9
Jul-09	0	7,754,021	0.01	2,534	2779.3
Aug-09	0	7,098,957	0.01	2,652	2782.1
Sep-09	0	6,704,344	0.01	2,747	2781.4
Oct-09	0	10,415,729	0.01	2,968	2782.7
Nov-09	0	9,463,404	0.01	3,296	2782.1
Dec-09	0	10,348,989	0.01	3,378	2782.1
Jan 2010	0	9,836,401	0.01	3,105	2778.5
Feb-10	0	9,311,065	0.01	2,187	2781.0
Mar-10	0	7,899,015	0.01	2,187	2781.0
Apr-10	0	11,243,545	0.01	2,846	2780.0
May-10	0	9,645,440	0.01	2,213	2780.0
Jun-10	0	9,587,093	0.01	2,695	2780.0
Jul-10	0	9,537,232	0.01	2,689	2779.2
Aug-10	0	9,582,465	0.01	2,788	2779.2

Sep-10	0	9,919,155	0.01	3,261	2781.7
Oct-10	0	3,665,900	0.01	3,342	2779.6
Nov-10	0	3,753,788	0.01	2,958	2779.2
Dec-10	0	4,630,778	0.01	3,208	2779.2
Jan-11	0	2,928,424	0.01	2,454	2721.0

Ambient temperature record, $f_{t,monthly}$ & $MCF_{baseline,m}$ calculations – 'Temp, ft, MCF' sheet of UP Biogas CER Calculation file

Month	**Data #5**		
	T_{lag} Ambient temperature	**$f_{t,monthly}$**	**$MCF_{baseline,m}$**
	°C		
May 2009	28.0	0.8455	0.3762
Jun 2009	28.3	0.8668	0.3857
Jul 2009	27.4	0.8057	0.3585
Aug 2009	27.2	0.7907	0.3519
Sep 2009	27.3	0.7985	0.3554
Oct 2009	27.2	0.7896	0.3514
Nov 2009	26.8	0.7615	0.3389
Dec 2009	27.0	0.7768	0.3457
Jan 2010	27.0	0.7766	0.3456
Feb 2010	28.2	0.8606	0.3830
Mar 2010	28.3	0.8697	0.3870
Apr 2010	28.5	0.8852	0.3939
May 2010	28.7	0.8969	0.3991
Jun 2010	28.0	0.8440	0.3756
Jul 2010	27.6	0.8208	0.3653
Aug 2010	28.0	0.8441	0.3756
Sep 2010	27.5	0.8076	0.3594
Oct 2010	28.0	0.8489	0.3778
Nov 2010	27.0	0.7792	0.3467
Dec 2010	26.1	0.7180	0.3195
Jan 2011	26.1	0.7211	0.3209

COD inflow and outflow calculations – 'COD in out' sheet of UP Biogas CER Calculation file

Month	Data #2	Data #15	Data #11	Data #1	Historical Data[7]	Derived		
						Total COD Inflow & Outflow, month		
	$COD_{c,baseline}$	$COD_{c,la}$	COD_{c,dig_out}	F_{dig}	AD	$COD_{baseline}$	COD_{dig_out}	$COD_{out,land}$
	kg/m³	kg/m³	kg/m³	m³	-	kg/m	kg/m	kg/m
May 2009	74.870	2.670	16.820	10,485	0.9434	740,580	176,358	27,995
Jun 2009	99.660	3.132	19.930	7,265	0.9434	683,050	144,791	22,754
Jul 2009	73.040	3.840	13.360	9,094	0.9434	626,631	121,496	34,921
Aug 2009	106.670	3.770	25.030	8,208	0.9434	825,991	205,446	30,944
Sep 2009	78.620	3.310	21.520	8,530	0.9434	632,671	183,566	28,234
Oct 2009	108.910	3.670	21.780	6,855	0.9434	704,322	149,302	25,158
Nov 2009	39.310	2.940	21.930	10,569	0.9434	391,952	231,778	31,073
Dec 2009	72.600	3.100	19.770	11,132	0.9434	762,440	220,080	34,509
Jan 2010	77.220	3.670	16.280	10,177	0.9434	741,388	165,682	37,350
Feb 2010	78.260	3.840	16.700	6,912	0.9434	510,316	115,430	26,542
Mar 2010	90.000	3.390	21.520	7,006	0.9434	594,851	150,769	23,750
Apr 2010	76.170	3.630	22.960	8,356	0.9434	600,452	191,854	30,332
May 2010*	55.280	3.540	17.106	8,043	0.9434	419,452	137,584	28,472
Jun 2010	67.490	3.890	9.930	10,092	0.9434	642,558	100,214	39,258
Jul 2010	72.000	3.320	15.200	10,152	0.9434	689,573	154,310	33,705
Aug 2010	50.250	3.216	18.890	10,060	0.9434	476,903	190,033	32,353
Sep 2010	78.000	5.120	17.200	11,662	0.9434	858,151	200,586	59,709
Oct 2010	76.190	4.010	15.240	11,065	0.9434	795,326	168,631	44,371
Nov 2010	69.825	4.389	11.571	10,042	0.9434	661,496	116,196	44,074
Dec 2010	78.392	4.101	17.286	10,346	0.9434	765,139	178,841	42,429

[7] Fixed at 0.9434 during validation stage of PDD. In-line with method and PDD (section B.6.3)

Jan 2011**	89.223	0.000	12.431	8,553	0.9434	719,931	106,322	0

**May 2010 CODc,dig_out is based on Unitata laboratory values. External laboratory result is not representable, as it is lower than CODc,la.*
***The external lab reported CODc,la as 22.055 kg/m3. If this value is applied, it will result in negative PElagoon. Hence, for Jan 2011 PElagoon calculation, CODc,la is equivalent to '0'.*

E.1. Baseline emissions calculation

The calculations of the lagoon baseline emissions and electricity (or thermal energy) baseline emissions are shown as follows.

As per section B.6 (Subchapter: Emission Reductions) of the PDD, the lower value of the following two methods should be used in order to calculate the Baseline Emissions (BE) from lagoon;

a) Baseline methane emissions less the physical leakage; *Ex-ante method*

b) The actual methane captured and flared/used for energy generation; *Ex-post method*

Based on AM0013 ver.04

Ex-ante (method a)

Baseline Emissions - Lagoon

$$\underset{(kg/yr)}{CH_4 \text{ emissions}} = \underset{(kg\ COD/month)}{\text{Total } COD_{available,m}} \times \underset{(kg\ CH_4/kg\ COD)}{B_o} \times MCF_{baseline}$$

Where:

$COD_{available,m}$ = Is the monthly Chemical Oxygen Demand available for conversion which is equal to the monthly COD entering the digester or directed to land application $COD_{baseline,m}$ plus COD carried on from the previous month.
$COD_{baseline,m}$ = Is the monthly Chemical Oxygen Demand of effluent entering lagoons or directed to land application (measured).
B_o = Is the maximum methane producing capacity. The default IPCC value is 0.25 kg
CH_4/kg COD = Taking into account the uncertainty of the estimate, a value of 0.21 kg CH_4/kg COD should be used as a conservative estimate.
$MCF_{baseline}$ = is the monthly methane conversion factor (fraction)

$$AD = 1 - \left[\frac{COD_{a,out}}{COD_{a,in}} \right]$$

Where:

$COD_{a,out}$ = is the COD that leaves the lagoon with the effluent (historical value)
$COD_{a,in}$ = is the COD that enters the lagoon (historical value)

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

Where:

f_d = is the fraction of anaerobic degradation due to depth as per table 1
f_t = is the fraction of anaerobic degradation due to temperature
0.89 = is an uncertainty conservativeness factor (for an uncertainty range of 30% to 50%) to account for the fact that the equation used to estimate f_t,monthly assumes full anaerobic degradation at $30^{O}C$.

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

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

Where:
$f_{t,monthly}$ = anaerobic degradation factor due to temperature.
E = Activation energy constant (15,175 cal/mol).
T_2 = Ambient temperature (Kelvin) for the climate.
T_1 = 303.16 (273.16° + 30°).
R = Ideal gas constant (1.987 cal/Kmol).

(Sheet '4 Baseline Emission Lagoon' of UP Biogas CER Calculation file)

Month	Derived							
	$COD_{baseline,m}$	$COD_{carry on,m}$	$COD_{available,m}$	$COD_{removed sludge}$	$f_{t,monthly}$	$MCF_{baseline,m}$	$CH_{4,emis,m}$	tCO_{2eq}
	kg/m	kg/m	kg/m	kg/m			kg/m	t/m
May 2009	740,580	1,114,207	1,854,788	0	0.8455	0.3762	146,548	3,077.51
Jun 2009	683,050	1,111,321	1,794,371	0	0.8668	0.3857	145,355	3,052.45
Jul 2009	626,631	1,128,250	1,754,880	0	0.8057	0.3585	132,134	2,774.81
Aug 2009	825,991	1,102,487	1,928,479	0	0.7907	0.3519	142,496	2,992.42
Sep 2009	632,671	1,212,248	1,844,919	0	0.7985	0.3554	137,675	2,891.17
Oct 2009	704,322	1,168,418	1,872,740	0	0.7896	0.3514	138,189	2,901.97
Nov 2009	391,952	1,212,947	1,604,899	0	0.7615	0.3389	114,212	2,398.46
Dec 2009	762,440	1,019,068	1,781,509	0	0.7768	0.3457	129,319	2,715.70
Jan 2010	741,388	1,131,363	1,872,751	0	0.7766	0.3456	135,905	2,854.01
Feb 2010	510,316	1,118,230	1,628,546	0	0.8606	0.3830	130,967	2,750.31
Mar 2010	594,851	971,740	1,566,591	0	0.8697	0.3870	127,320	2,673.73
Apr 2010	600,452	925,719	1,526,171	0	0.8852	0.3939	126,252	2,651.29
May 2010	419,452	886,683	1,306,134	0	0.8969	0.3991	109,479	2,299.07
Jun 2010	642,558	787,075	1,429,634	0	0.8440	0.3756	112,764	2,368.05
Jul 2010	689,573	868,198	1,557,771	0	0.8208	0.3653	119,486	2,509.20
Aug 2010	476,903	938,922	1,415,825	0	0.8441	0.3756	111,683	2,345.35
Sep 2010	858,151	874,654	1,732,804	0	0.8076	0.3594	130,774	2,746.26
Oct 2010	795,326	1,018,479	1,813,806	0	0.8489	0.3778	143,895	3,021.80
Nov 2010	661,496	1,140,531	1,802,027	0	0.7792	0.3467	131,212	2,755.45
Dec 2010	765,139	1,166,577	1,931,716	0	0.7180	0.3195	129,607	2,721.74
Jan 2011	719,931	1,269,389	1,989,320	0	0.7211	0.3209	134,061	2,815.27

Ex-post (method B)

$$\textbf{CH}_4\ \textbf{emissions (kg/yr)} = \textbf{FR}_{bio} \times \textbf{P}_{CH4,bio} \times \boldsymbol{\rho}_{CH4}$$

Where:
FR_{bio} = Amount of biogas collected in the outlet of the Bio-digester measured using a continuous flow meter (Nm^3)
$P_{CH4,bio}$ = Percentage of biogas that is methane in the outlet of the biodigester (%)
ρ_{CH4} = Methane density (0.668) (kg/Nm^3)

Month	Data #18	Data #19	Derived		Derived	
	Total Biogas Collected	Methane Content in Biogas	Total Available Methane	Methane Density	$CH_{4,emis,m}$	BE
	m^3	%	m^3	kg/m^3	t/mth	tCO_{2eq}/mth
May 2009	410,033	55.35	226,953	0.668	151.60	3,183.70
Jun 2009	242,320	57.79	140,037	0.668	93.54	1,964.44
Jul 2009	354,208	61.90	219,255	0.668	146.46	3,075.71
Aug 2009	371,239	57.91	214,985	0.668	143.61	3,015.80
Sep 2009	388,408	57.91	224,927	0.668	150.25	3,155.28
Oct 2009	444,387	57.06	253,567	0.668	169.38	3,557.04
Nov 2009	418,347	58.44	244,482	0.668	163.31	3,429.59
Dec 2009	425,956	59.08	251,655	0.668	168.11	3,530.21
Jan 2010	402,686	61.54	247,813	0.668	165.54	3,476.32
Feb 2010	287,830	58.62	168,726	0.668	112.71	2,366.89
Mar 2010	278,447	58.19	162,028	0.668	108.23	2,272.93
Apr 2010	366,132	59.07	216,274	0.668	144.47	3,033.89
May 2010	299,215	57.03	170,642	0.668	113.99	2,393.77
Jun 2010	368,500	59.40	218,889	0.668	146.22	3,070.57
Jul 2010	362,341	59.81	216,716	0.668	144.77	3,040.09
Aug 2010	363,721	57.86	210,449	0.668	140.58	2,952.18
Sep 2010	430,769	59.47	256,178	0.668	171.13	3,593.67
Oct 2010	447,338	58.49	261,648	0.668	174.78	3,670.40
Nov 2010	384,071	58.84	225,987	0.668	150.96	3,170.15
Dec 2010	412,498	59.52	245,519	0.668	164.01	3,444.14
Jan 2011	319,475	58.97	188,394	0.668	125.85	2,642.80

Baseline Emissions – Electricity (Heat) (Only the thermal energy section of this formula is applicable to the calculations)

Two methods have been used to derive the baseline emissions from electricity (heat); the *methane input multiplied with methane calorific value* and *steam generated multiplied steam enthalpy.* For the current monitoring period, the former method results in 145,651 GJ of energy displaced, whereas the latter results in 161,186 GJ of energy displaced. The more conservative method, which is the former method, is chosen and described further below.

Based on AM0013 ver.04

$$BE_{elec/heat} = EG_y * CEF_{Bl,elec,,y} + EG_{d,y} * CEF_{grid} + HG_{Bl,y} * CEF_{Bl,therm,y}$$

Where:

EG_y = Is the amount of electricity in the year y that would be consumed at the project site in the absence of the project activity (MWh).

$CEF_{Bl,elec,y}$ = Is the CO_2 emission factor for electricity consumed at the project site in the absence of the project activity (tCO_{2eq}/MWh)

$EG_{d,y}$ = Is the amount of electricity generated utilizing the biogas collected during project activity and exported to the grid during the year y (MWh)

CEF_{grid} = Is the CO_2 emission factor for the grid where electricity is exported tCO_{2eq}/MWh)

$HG_{Bl,y}$ = Is the quantity of thermal energy that would be consumed in year y at the project site in the absence of the project activity (MJ) using fossil fuel.

$CEF_{Bl,therm,y}$ = Is the CO_2 emissions intensity for thermal energy generation (tCO_{2eq}/MJ)

(Sheet '5 Baseline Boiler Emission' of UP Biogas CER Calculation file)

Month	Data #28				
	Biogas Consumed In Boiler	Methane Volume in Biogas Consumed	Thermal Energy from Methane	Thermal Energy Generated by Boiler	BE_{heat}
	Nm^3/mth	Nm^3/mth	TJ/mth	TJ/mth	tCO_{2eq}/mth
May 2009	410,033	226,953	8.12	6.91	521.42
Jun 2009	212,960	123,070	4.41	3.75	282.75
Jul 2009	354,208	219,255	7.85	6.67	503.73
Aug 2009	371,239	214,985	7.70	6.54	493.92
Sep 2009	388,408	224,927	8.05	6.84	516.76
Oct 2009	444,387	253,567	9.08	7.72	582.56
Nov 2009	418,347	244,482	8.75	7.44	561.69
Dec 2009	425,956	251,655	9.01	7.66	578.17
Jan 2010	402,686	247,813	8.87	7.54	569.34
Feb 2010	287,830	168,726	6.04	5.13	387.64
Mar 2010	278,447	162,028	5.80	4.93	372.25
Apr 2010	366,132	216,274	7.74	6.58	496.88
May 2010	299,215	170,642	6.11	5.19	392.04
Jun 2010	368,500	218,889	7.84	6.66	502.89
Jul 2010	362,341	216,716	7.76	6.59	497.90
Aug 2010	363,721	210,449	7.53	6.40	483.50
Sep 2010	430,769	256,178	9.17	7.80	588.56
Oct 2010	447,338	261,648	9.37	7.96	601.13
Nov 2010	384,071	225,987	8.09	6.88	519.20
Dec 2010	412,498	245,519	8.79	7.47	564.07
Jan 2011	319,475	188,394	6.74	5.73	432.83

E.2. Project emissions calculation

The project emissions for the project are from the sources below;

a) Lagoon
b) Tank leakage
c) Flare & Boiler
d) Electricity consumption
e) Sludge for land application

Project Emissions - Lagoon

Based on AM0013 ver.04

$$\underset{\text{(kg/yr)}}{\text{CH}_4\text{ emissions from the lagoons}} = \underset{\text{(kg COD/yr)}}{COD_{dig\_out}} \times \underset{\text{(kg CH}_4\text{/kg COD)}}{B_o} \times MCF_{dig\_out}$$

Where:
COD_{dig_out} = Is Chemical Oxygen Demand of effluent entering lagoons (measured)
B_o = Is maximum methane producing capacity as in the baseline
MCF_{dig_out} = Is methane conversion factor (fraction) estimated as described in the baseline section above

(Sheet '6 Project Emissions Lagoon' of UP Biogas CER Calculation file)

Month	Derived		
	$COD_{dig\ out}$	CH_4 emission	CH_4 emission from lagoon
	kg/month	kg/month	tCO_{2eq}/month
May 2009	176,358	13,934	292.62
Jun 2009	144,791	11,729	246.31
Jul 2009	121,496	9,148	192.11
Aug 2009	205,446	15,181	318.79
Sep 2009	183,566	13,698	287.67
Oct 2009	149,302	11,017	231.36
Nov 2009	231,778	16,494	346.38
Dec 2009	220,080	15,976	335.49
Jan 2010	165,682	12,023	252.49
Feb 2010	115,430	9,283	194.94
Mar 2010	150,769	12,253	257.32
Apr 2010	191,854	15,871	333.29
May 2010	137,584	11,532	242.18
Jun 2010	100,214	7,904	165.99
Jul 2010	154,310	11,836	248.56
Aug 2010	190,033	14,990	314.80
Sep 2010	200,586	15,138	317.90
Oct 2010	168,631	13,378	280.94
Nov 2010	116,196	8,461	177.67
Dec 2010	178,841	11,999	251.98
Jan 2011	106,322	7,165	150.47

Project Emissions – Tank Leakage

Based on AM0013 ver.04

$$\mathbf{PE_{CH4\_leak} = Q_{CH4} \times 1\% \times GWP}$$

Where:
Q_{CH4} = Is quantity of methane generated in the digesters for the month (tCH_4/mth)
GWP = Global warming potential of methane (21)

$$\mathbf{Q_{CH4} = COD_t \times EF}$$

Where:
COD_t = Is quantity of COD generated in the digesters for the month (kgCOD/mth)
EF = Emission factor of methane

$$\mathbf{EF = B_o \times MCF}$$

Where:
B_o = Maximum methane production potential (0.25 kgCH4/kg COD used, in-line with pg 34 of PDD)
MCF = Methane correction factor (0.85; based on published data for anaerobic digesters, pg 34 of PDD)

Sheet '7Project Emission Tank Leakage' of UP Biogas CER Calculation file

Month	Derived		
	COD_t	Q_{CH4}	PE_{CH4_leak}
	kg/month	t CH_4/month	t CO_{2eq}/month
May 2009	785,012	167	35.03
Jun 2009	724,030	154	32.31
Jul 2009	664,226	141	29.64
Aug 2009	875,547	186	39.07
Sep 2009	670,629	143	29.93
Oct 2009	746,578	159	33.32
Nov 2009	415,467	88	18.54
Dec 2009	808,183	172	36.07
Jan 2010	785,868	167	35.07
Feb 2010	540,933	115	24.14
Mar 2010	630,540	134	28.14
Apr 2010	636,477	135	28.40
May 2010	444,617	94	19.84
Jun 2010	681,109	145	30.39
Jul 2010	730,944	155	32.62
Aug 2010	505,515	107	22.56
Sep 2010	909,636	193	40.59
Oct 2010	843,042	179	37.62
Nov 2010	701,183	149	31.29
Dec 2010	811,044	172	36.19
Jan 2011	763,124	162	34.05

Project Emissions – Flare & Boiler

Based on ''Tool to determine project emissions from flaring gases containing methane'' ver. 01

STEP 1: Determination of mass flow rate of the residual gas that is flared

$$FM_{RG,h} = \rho_{RG,n,h} \times FV_{RG,h}$$

Where:

Variable	SI Unit	Description
$FM_{RG,h}$	kg/h	Mass flow rate of the residual gas in hour h
$\rho_{RG,n,h}$	kg/m^3	Density of the residual gas at normal conditions in hour h
$FV_{RG,h}$	m^3/h	Volumetric flow rate of the residual gas in dry basis at normal conditions in the hour h

$$\rho_{RG,n,h} = \frac{P_n}{\frac{R_u}{MM_{RG,h}} \times T_n}$$

Where:

Variable	SI Unit	Description
$\rho_{RG,n,h}$	kg/m^3	Density of the residual gas at normal conditions in hour h
P_n	Pa	Atmospheric pressure at normal conditions (101325)
R_u	$Pa.m^3/kmol.K$	Universal ideal gas constant (8 314)
$MM_{RG,h}$	kg/kmol	Molecular mass of the residual gas in hour h
T_n	K	Temperature at normal conditions (273.15)

$$MM_{RG,h} = \sum_i (fv_{i,h} * MM_i)$$

Where:

Variable	SI Unit	Description
$MM_{RG,h}$	kg/kmol	Molecular mass of the residual gas in hour h
$fv_{i,h}$	-	Volumetric fraction of component i in the residual gas in the hour h
MM_i	kg/kmol	Molecular mass of residual gas component i
i		The components CH_4, CO, CO_2, O_2, H_2, N_2

STEP 2: Determination of the mass fraction of carbon, hydrogen, oxygen and nitrogen in the residual gas

(As a simplified approach, project participant only measures volumetric fraction of methane and considers the difference to 100% as being carbon dioxide)

$$fm_{j,h} = \frac{\sum_i fv_{i,h} \cdot AM_j \cdot NA_{j,i}}{MM_{RG,h}}$$

Where:

Variable	SI Unit	Description
$fm_{j,h}$	-	Mass fraction of element j in the residual gas in hour h
$fv_{i,h}$	-	Volumetric fraction of component i in the residual gas in the hour h
AM_j	kg/kmol	Atomic mass of element j
$NA_{j,i}$	-	Number of atoms of element j in component i
$MM_{RG,h}$	kg/kmol	Molecular mass of the residual gas in hour h
j		The elements carbon, hydrogen, oxygen and nitrogen
i		The components CH_4, CO, CO_2, O_2, H_2, N_2

Step 3 and 4 is not applicable as methane combustion efficiency is not continuously monitored but fixed at 50% (if temperature is above 500^0C for more than 20minutes for the hour *h*).

STEP 5: Determination of methane mass flow rate in the residual gas on a dry basis

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

Where:

Variable	SI Unit	Description
$TM_{RG,h}$	kg/h	Mass flow rate of methane in the residual gas in the hour h
$FV_{RG,h}$	m^3/h	Volumetric flow rate of the residual gas in dry basis at normal conditions in hour h
$fv_{CH4,RG,h}$	-	Volumetric fraction of methane in the residual gas on dry basis in hour h (NB: this corresponds to $fv_{i,RG,h}$ where i refers to methane).
$\rho_{CH4,n}$	kg/m^3	Density of methane at normal conditions (0.716)

Step 6 is not applicable as methane flaring efficiency, $\eta_{flare,h}$ is fixed at 50% for open flare (if temperature is above 500^0C for more than 20minutes for the hour *h*).

STEP 7: Calculation of annual project emissions from flaring

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

Where:

Variable	SI Unit	Description
$PE_{flare,y}$	tCO_{2eq}	Project emissions from flaring of the residual gas stream in year y

$TM_{RG,h}$	kg/h	Mass flow rate of methane in the residual gas in the hour h
$\eta_{flare,h}$	-	Flare efficiency in hour h
GWP_{CH4}	tCO_{2eq}/tCH_4	Global Warming Potential of methane valid for the commitment period

Sheet '8Project Emission Flare & Boiler' of UP Biogas CER Calculation file

Month	Data #29	Data #30			Data #22	
	$FR_{e,s}$	$P_{CH4,e,s}$	CH_4 emission in boiler stack	Emission due to combustion of CH_4		Total CH_4 emission
				Boiler	$PE_{flare,y}$	
	Nm^3	%	kg/month	tCO_{2eq}/mth	tCO_{2eq}/mth	tCO_{2eq}/mth
May 2009	9,319,430	0.01	664.48	13.954	0.00	13.95
Jun 2009	5,168,498	0.01	368.51	7.739	441.46	449.20
Jul 2009	7,754,021	0.01	552.86	11.610	0.00	11.61
Aug 2009	7,098,957	0.01	506.16	10.629	0.00	10.63
Sep 2009	6,704,344	0.01	478.02	10.038	0.00	10.04
Oct 2009	10,415,729	0.01	742.64	15.595	0.00	15.60
Nov 2009	9,463,404	0.01	674.74	14.170	0.00	14.17
Dec 2009	10,348,989	0.01	737.88	15.496	0.00	15.50
Jan 2010	9,836,401	0.01	701.34	14.728	0.00	14.73
Feb 2010	9,311,065	0.01	663.88	13.941	0.00	13.94
Mar 2010	7,899,015	0.01	563.20	11.827	0.00	11.83
Apr 2010	11,243,545	0.01	801.66	16.835	0.00	16.83
May 2010	9,645,440	0.01	687.72	14.442	0.00	14.44
Jun 2010	9,587,093	0.01	683.56	14.355	0.00	14.35
Jul 2010	9,537,232	0.01	680.00	14.280	0.00	14.28
Aug 2010	9,582,465	0.01	683.23	14.348	0.00	14.35
Sep 2010	9,919,155	0.01	707.24	14.852	0.00	14.85
Oct 2010	3,665,900	0.01	261.38	5.489	0.00	5.49
Nov 2010	3,753,788	0.01	267.65	5.621	0.00	5.62
Dec 2010	4,630,778	0.01	330.17	6.934	0.00	6.93
Jan 2011	2,928,424	0.01	208.80	4.38	0.00	4.38

Project Emissions – Electricity Consumption

Based on AM0013 ver.04

$$PE_{elec/heat} = EL_y * CEF_d + HG_{Pr,y} * CEF_{Pr,therm,y}$$

$EL_{P,y}$ = Is the amount of electricity in the year y that is consumed at the project site for the project activity (MWh).
CEF_d = Is the CO_2 emissions factor for electricity consumed at the project site during the project activity (tCO_{2eq}/MWh), estimated as described below. Factor is zero if biogas is used to produce electricity.
$HG_{Pr,y}$ =Is the quantity of thermal energy consumed in year y at the project site due to the project activity (MJ).
$CEF_{Pr,therm,y}$ = Is the CO_2 emissions intensity for thermal energy generation (tCO_{2eq}/MJ), estimated as per method described for baseline thermal energy use. Factor is zero if biogas is used for generating thermal energy.

Sheet '9Project Emission Electricity Consumption' of UP Biogas CER Calculation file

Month	No. of days in the particular month	No. Of hours in the particular month	Power supply		$EL_{Pr,y}$	Power consumed from grid for project activity	Emissions from electricity consumption from grid
				Derived	Data #12	Derived	
			From biomass boiler	From grid			
	days	hrs	hrs	hrs	kWh/month	MWh/month	tCO_{2eq}/month
May 2009	31	744	490	254	41,036.0	14.036	8.84
Jun 2009	30	720	462	258	41,348.0	14.816	9.33
Jul 2009	31	744	330	414	42,764.4	23.818	15.01
Aug 2009	31	744	543	201	42,432.4	11.464	7.22
Sep 2009	30	720	576	144	41,460.0	8.270	5.21
Oct 2009	31	744	585	159	43,212.4	9.259	5.83
Nov 2009	30	720	504	216	42,060.0	12.606	7.94
Dec 2009	31	744	450	294	43,624.4	17.215	10.85
Jan 2010	31	744	166	578	42,864.4	33.318	20.99
Feb 2010	28	672	122	550	35,091.2	28.720	18.09
Mar 2010	31	744	293	451	37,384.4	22.654	14.27
Apr 2010	30	720	272	448	41,448.0	25.778	16.24
May 2010	31	744	274	470	41,484.4	26.205	16.51
Jun 2010	30	720	377	343	41,724.0	19.874	12.52
Jul 2010	31	744	471	273	40,067.6	14.716	9.27
Aug 2010	31	744	424	320	41,500.4	17.861	11.25
Sep 2010	30	720	422	298	41,428.0	17.147	10.80
Oct 2010	31	744	378	366	42,024.4	20.658	13.01
Nov 2010	30	720	331	389	40,468.0	21.884	13.79
Dec 2010	31	744	283	461	41,156.4	25.482	16.05
Jan 2011	31	744	121	623	41,052.4	34.357	21.64

Project Emissions – Land application of sludge; **Sheet '10 Project Emission Land Application Sludge'** ***of UP Biogas CER Calculation file***

Based on AM0013 ver.04

Month	Data #14	Data #15	Derived		
	F_{la}	$COD_{c,la}$	Total COD applied to land	CH_4 emission from land application	Emission from land application
	m^3	kg/m^3	kg/month	kg/month	tCO_{2eq}/month
May 2009	2,550	2.670	6,809	71	1.50
Jun 2009	4,085	3.132	12,794	134	2.82
Jul 2009	5,288	3.840	20,304	213	4.48
Aug 2009	4,557	3.770	17,180	180	3.79
Sep 2009	4,447	3.310	14,720	155	3.25
Oct 2009	5,408	3.670	19,849	208	4.38
Nov 2009	7,642	2.940	22,468	236	4.95
Dec 2009	6,565	3.100	20,351	214	4.49
Jan 2010	7,533	3.670	27,644	290	6.10
Feb 2010	7,855	3.840	30,163	317	6.65
Mar 2010	5,386	3.390	18,259	192	4.03
Apr 2010	5,827	3.630	21,151	222	4.66
May 2010	8,685	3.540	30,746	323	6.78
Jun 2010	8,428	3.890	32,786	344	7.23
Jul 2010	7,995	3.320	26,543	279	5.85
Aug 2010	5,406	3.216	17,386	183	3.83
Sep 2010	4,476	5.120	22,918	241	5.05
Oct 2010	7,218	4.010	28,945	304	6.38
Nov 2010	6,715	4.389	29,473	309	6.50
Dec 2010	8,029	4.101	32,928	346	7.26
Jan 2011*	8,649	22.055	190,743	2,003	42.06

**The external lab reported CODc,la as 22.055 kg/m3. Value maintained for project emissions from land application calculation.*

Project Emissions – Land application of sludge (cont.)

Based on AM0013 ver.04

Month		Data #32	Data #33	Derived		Derived
	Concentration of sludge solid applied to land	S_O	NC	N_2O emission	N_2O emission	Total emission from land application and sludge
	kg/m3	kg sludge	kg N/kg sludge	kg/month	tCO_{2eq}/month	tCO_{2eq}/month
May 2009	1.415	3608.392	0.00231	0.13	0.04	1.54
Jun 2009	0.580	2369.300	0.00232	0.09	0.03	2.85
Jul 2009	0.830	4388.708	0.00227	0.16	0.05	4.53
Aug 2009	1.640	7473.316	0.00234	0.28	0.09	3.87
Sep 2009	0.958	4260.226	0.00258	0.18	0.05	3.30
Oct 2009	1.525	8247.810	0.00232	0.31	0.09	4.47
Nov 2009	1.013	7741.549	0.00217	0.27	0.08	5.04
Dec 2009	0.873	5731.070	0.00208	0.19	0.06	4.55
Jan 2010	0.710	5348.075	0.00233	0.20	0.06	6.16
Feb 2010	1.635	12842.925	0.00221	0.45	0.14	6.79
Mar 2010	1.085	5844.027	0.00247	0.23	0.07	4.10
Apr 2010	0.780	4544.904	0.00288	0.21	0.06	4.73
May 2010	0.910	7903.532	0.00253	0.32	0.10	6.88
Jun 2010	0.557	4694.5631	0.00234	0.18	0.05	7.28
Jul 2010	1.245	9953.526	0.00218	0.35	0.11	5.96
Aug 2010	2.630	14217.78	0.00203	0.46	0.14	3.98
Sep 2010	2.160	9668.592	0.00207	0.32	0.10	5.15
Oct 2010	2.050	14797.105	0.00210	0.50	0.15	6.54
Nov 2010	1.775	11919.48	0.00212	0.40	0.13	6.62
Dec 2010	1.490	11963.508	0.00202	0.39	0.12	7.38
Jan 2011	1.793	15506.761	0.002	0.53	0.16	42.22

E.3. Leakage calculation

Not applicable. The technology and machinery for the project activity is not transferred from another activity and thus no leakage is considered to take place.

E.4. Emission reductions calculation / table

Emission reductions

Emission reductions are calculated as the difference between baseline and project emissions, taking into account any adjustments for leakage.

Baseline Emissions (tCO_{2eq})	=	Baseline emissions from lagoons (tCO_{2eq})	+	Baseline emission from portion of fossil fuel displaced by boiler in heat generating equipment (tCO_{2eq})

Project emissions (tCO_{2eq})	=	Project emissions from lagoon (tCO_{2eq})	+	Project emissions from tank leakage (tCO_{2eq})	+	Project emissions from flare & boiler (tCO_{2eq})	+	Project emission from electricity consumption (tCO_{2eq})	+	Project emissions from sludge for land application (tCO_{2eq})

Emission reductions (tCO_{2eq})	=	Baseline emissions (tCO_{2eq})	+	Project emissions (tCO_{2eq})

Sheet '11 Project ER' of UP Biogas CER Calculation file

Month	Baseline Emissions (BE)			Project Emissions (PE)						ER
	BE from lagoon (ex-ante)	BE from boiler	Total BE	PE from lagoon	PE AD tank leakage	PE Flare & boiler stack	PE Electricity consumption	PE Land application of sludge	Total PE	Emission Reductions
	tCO_{2eq}	tCO_{2eq}	tCO_{2eq}	tCO_{2eq}	tCO_{2eq}	tCO_{2eq}	tCO_{2eq}	tCO_{2eq}	tCO_{2eq}	tCO_{2eq}
May 2009	3,077.51	521.42	3598.93	292.62	35.03	13.95	8.84	1.54	351.99	3246.94
Jun 2009	3,052.45	282.75	3335.20	246.31	32.31	449.20	9.33	2.85	740.00	2595.20
Jul 2009	2,774.81	503.73	3278.54	192.11	29.64	11.61	15.01	4.53	252.89	3025.65
Aug 2009	2,992.42	493.92	3486.34	318.79	39.07	10.63	7.22	3.87	379.59	3106.75
Sep 2009	2,891.17	516.76	3407.93	287.67	29.93	10.04	5.21	3.30	336.14	3071.79
Oct 2009	2,901.97	582.56	3484.53	231.36	33.32	15.60	5.83	4.47	290.57	3193.96
Nov 2009	2,398.46	561.69	2960.15	346.38	18.54	14.17	7.94	5.04	392.07	2568.08
Dec 2009	2,715.70	578.17	3293.87	335.49	36.07	15.50	10.85	4.55	402.44	2891.43
Jan 2010	2,854.01	569.34	3423.35	252.49	35.07	14.73	20.99	6.16	329.44	3093.91
Feb 2010	2,750.31	387.64	3137.95	194.94	24.14	13.94	18.09	6.79	257.91	2880.04
Mar 2010	2,673.73	372.25	3045.98	257.32	28.14	11.83	14.27	4.10	315.65	2730.33
Apr 2010	2,651.29	496.88	3148.17	333.29	28.40	16.83	16.24	4.73	399.50	2748.67
May 2010	2,299.07	392.04	2691.11	242.18	19.84	14.44	16.51	6.88	299.85	2391.27
Jun 2010	2,368.05	502.89	2870.94	165.99	30.39	14.35	12.52	7.28	230.55	2640.39
Jul 2010	2,509.20	497.90	3007.10	248.56	32.62	14.28	9.27	5.96	310.69	2696.41
Aug 2010	2,345.35	483.50	2828.85	314.80	22.56	14.35	11.25	3.98	366.93	2461.92
Sep 2010	2,746.26	588.56	3334.82	317.90	40.59	14.85	10.80	5.15	389.30	2945.52
Oct 2010	3,021.80	601.13	3622.93	280.94	37.62	5.49	13.01	6.54	343.60	3279.33
Nov 2010	2,755.45	519.20	3274.65	177.67	31.29	5.62	13.79	6.62	235.00	3039.66
Dec 2010	2,721.74	564.07	3285.81	251.98	36.19	6.93	16.05	7.38	318.54	2967.27
Jan 2011	2815.27	432.83	3248.10	150.47	34.05	4.38	21.64	42.22	252.77	2995.33
Total			**67,765**						**7,196**	**60,569**

E.5. Comparison of actual emission reductions with estimates in the CDM-PDD

The total emission reduction of the monitoring period (21 months) is 60,569 tCO_{2eq}; the baseline emission is 67,765 tCO_{2eq} and the project emission is 7,196 tCO_{2eq}.The emission reductions estimated for same period in the PDD was 35,474 $tCO_{2eq.}$ A comparison of the differences between the actual monitored values between the period 01/05/09 - 31/01/2011 and the PDD projection is provided below.

Item	Values applied in ex-ante calculation of the registered CDM-PDD	Actual values reached during the monitoring period (prorated to a 12 months period)
Baseline Emissions (tCO_{2eq})	24,510	38,723
Project Emissions (tCO_{2eq})	4,239	4,112
Emission reductions (tCO_{2eq})	**20,271**	**34,611**

**Actual values (collected over a period of 21 months) are pro-rated to a period of 12 months, in order to compare it with the ex-ante estimations.*

Item	Difference	Percentage Difference
Baseline Emissions (tCO_{2eq})	14,213	58%
Project Emissions (tCO_{2eq})	-127	-3%
Emission reductions (tCO_{2eq})	**14,340**	**71%**

E.6. Remarks on difference from estimated value in the PDD

The actual emission reductions (ER) achieved in this monitoring period is 60,569 tCO_{2eq}. The estimated value in the PDD is 20,271 tCO_{2eq} for a period of 12 months. Thus, by comparing a pro-rated 12 months figure of the actual ER achieved with the PDD value, the emission reductions achieved is 34,611 tCO_{2eq} (pro-rated 12-months figure), which shall be compared to the emission reductions estimated ex-ante in PDD amounting to 20,271 tCO_{2eq}.

The increase in ER is mainly due to the following factors;

1) **COD value of the incoming POME.**
The average COD value ($COD_{c,baseline}$) achieved during the monitoring period is 76.76 $kgCOD/m^3$. This is a parameter beyond the project proponent's control as the wastewater that leaves the mill consists of sources from the mill operation; eg steam from the sterilizer, wash water from the mill, hydro cyclone water, EFB press etc. The organic composition and loading of the raw effluent from the palm oil mill is outside the project boundary and not under control by the biogas plant.

Prior to the registration of the project activity, the POME from the mill registered COD values in the range of 44.00 $kgCOD/m^3$ to 103.00 $kgCOD/m^3$, with an average of 74.63 $kgCOD/m^3$. During validation it was decided to use a more conservative value of 52.00 $kgCOD/m^3$, for ex-ante estimation of the emission reductions. This value is the industrial average COD value for raw effluent informed by the Malaysian Palm Oil Board (MPOB); refer PDD page 30.

Parameter	PDD value Kg/m^3	Actual value Kg/m^3	Change Pct.
$COD_{c,baseline}$	52.00	76.76	+48%

As the $COD_{c,baseline}$ is 48% higher during the monitoring period as compared to the ex-ante assumption applied in the PDD ($COD_{a,in}$), this increase explains the main factor for the increase in baseline emissions. The value during the monitoring period of 76.76 kg/m^3 is very close to the average historic COD value provided in the PDD annex A3.1, which was 74.633 mg/l.

2) **Reduced flaring activities**
In the PDD, flaring was estimated to consume 15% of the biogas produced (page 32 of registered CDM PDD). Flaring activity would generate higher project emissions, since an open-flare system (50% efficiency) is installed at site. Nevertheless, since the demand from the refinery has been consistent throughout the monitoring period (minimal or no downtime), flaring was only carried out in the month of June 2009, for the entire monitoring period. The percentage of biogas used for flaring for the monitoring period is 0.4%; 29,360 m^3 gas flared out of a total 7,777,921 Nm^3 gas produced from the CSTR tanks.

Parameter	PDD value	Actual value (01/05/09 – 31/01/2011)	Pro rated value (1 yr) Nm^3/yr	Change
$FR_{f,inlet}$ (Nm^3)	446,336	29,360	16,777	- 96%
Project emissions from flare & boiler (tCO_{2eq})	2,325	693	396	-1929

These 2 factors are the main contributors to the increase of CERs, during the monitoring period. The total increase in emission reduction is 14,340 tCO_{2eq}, as compared with the PDD.

- - - - -

History of the document

Version	Date	Nature of revision
01	EB 54, Annex 34 28 May 2010	Initial adoption.
Decision Class: Regulatory **Document Type**: Guideline, Form **Business Function**: Issuance		