MONITORING REPORT FORM (F-CDM-MR)
Version 02.0

MONITORING REPORT

Title of the project activity	Nubika Jaya Biogas Extraction for Bio-Hydrogen Production
Reference number of the project activity	2421
Version number of the monitoring report	1.0
Completion date of the monitoring report	09/10/2012
Registration date of the project activity	30/06/2009
Monitoring period number and duration of this monitoring period	Monitoring Period No. 2 (01/08/2010 – 31/07/2012)
Project participant(s)	1) PT Nubika Jaya 2) Mitsubishi UFJ Morgan Stanley Securities Co., Ltd.
Host Party(ies)	Indonesia
Sectoral scope(s) and applied methodology(ies)	13: Waste Handling and Disposal 5: Chemical industries AMS-III.H (Version 09) AMS-III.O (Version 01)
Estimated amount of GHG emission reductions or net anthropogenic GHG removals by sinks for this monitoring period in the registered PDD	88,362 tCO_2
Actual GHG emission reductions or net anthropogenic GHG removals by sinks achieved in this monitoring period	**27,356 tCO_2**

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

PT Nubika Jaya ("NUBIKA") is one of the subsidiary companies of Permata Hijau Group (PHG), a fully integrated oil palm corporation with core business in the oil palm plantation, edible oil refining, kernel crushing, and oleochemical manufacturing. It is a limited liability company registered under local government City of Medan, Industrial and Trade Agency with current Registration Number 02.12.1.01.06911 dated 22/09/2008.

NUBIKA implemented a biogas extraction facility to extract biogas from organically loaded wastewater primarily generated by NUBIKA's palm fruit milling activity. The biogas produced is then treated to remove the sulphur content so that it is suitable to be used as feedstock and fuel to the hydrogen production plant. Alternatively, any excess biogas not utilized for hydrogen production is flared off. Greenhouse Gas Emission Reduction is achieved by the methane capture, flaring, and hydrogen production using biogas.

Effluent generated by NUBIKA activities primarily comes from raw fruit cooking activity and liquor from the remaining empty fruit bunches in the palm oil mill. Other processing facilities that are already in operations, i.e. the kernel crushing plant and refinery, contribute a much smaller proportion of wastewater.

The biogas is collected from the wastewater by the new Methane Capture System (MCS). The extracted biogas then goes through biogas purification system for H_2S removal before it is supplied to hydrogen production process, while the excess biogas is flared by using an open flare system. The use of biogas for hydrogen production effectively displaces LPG as feedstock and fuel in the hydrogen production unit.

The project started on 15/10/2006 based on the time of contract signing with the main technology provider Aquarius Systems Sdn. Bhd and the permission for construction of Methane Capture System (MCS), Anaerobic Digester, and biogas purification system to support hydrogen production was then obtained on 13/02/2007. The environment mitigation and monitoring plan (UPL/UKL) was approved by local government on 10/06/2008.

The project has been approved by Indonesia DNA, National Committee on CDM (NC-CDM) on 25/09/2008 and officially registered with CDM Executive Board on 30/06/2009 with registration number 2421. The construction of Methane Capture System (MCS) and biogas treatment facility to support hydrogen production started in 2007 and they were commissioned in early 2009.

Due to the delay in the installation of CDM monitoring instruments, the crediting period of the project activity started on 01/05/2010 through the procedure of post-registration changes to the start date of the crediting period. The verification of 1st Monitoring Period from 01/05/2010 to 31/07/2010 has been completed and the project has been successfully issued with CERs on 27/04/2012.

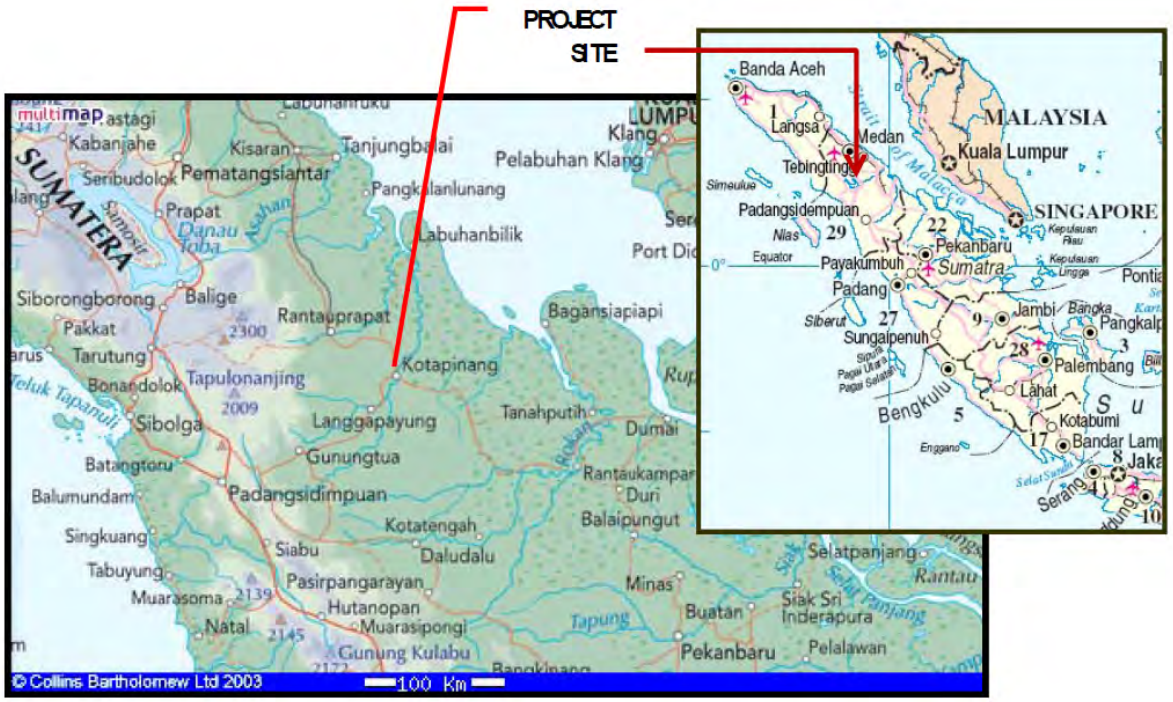
The total Emission Reduction claimed for the 2nd Monitoring Period from 01/08/2010 to 31/07/2012 is **27,356 tCO_2e.**

A.2. Location of project activity

Country: Indonesia
Prefecture: North Sumatera

Village: Sisumut,
Subdistrict: Kota Pinang
Regency: Labuhan Batu

Kota Pinang is located at 1° 53' 51"N and 100° 04'59"E. The Project is located within the boundary of NUBIKA's palm oil mill facility, adjacent to the existing wastewater treatment lagoons.



A.3. Parties and project participant(s)

Party involved ((host) indicates a host Party)	Private and/or public entity(ies) project participants (as applicable)	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
Indonesia (host)	PT Nubika Jaya (Private Entity)	No
Japan	Mitsubishi UFJ Morgan Stanley Securities Co., Ltd. (Private Entity)	No

A.4. Reference of applied methodology

AMS-III.H Version 09 "Methane Recovery in Wastewater Treatment"
http://cdm.unfccc.int/UserManagement/FileStorage/CDMWF_AM_743QMM1YKHH15AK2AZAVAIJHRGD5R7

AMS-III.O Version 01 "Hydrogen Production Using Methane Extracted from Biogas"
http://cdm.unfccc.int/UserManagement/FileStorage/CDM_AMSW050DMNAAJAQZVK9ELW2IIPVVMXDQL

Methodological Tools:
"*Tool to determine project emissions from flaring gases containing methane*", Annex 13, approved in EB28.
http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-06-v1.pdf

"*Tool to calculate project or leakage CO_2 emission from fossil fuel combustion*", Annex 09, approved in EB32
http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-03-v1.pdf

A.5. Crediting period of project activity

As per registered PDD, the project chooses renewable crediting period. The length of the first crediting period is 7 years.

The crediting period of the project activity is from **01/05/2010** to **30/04/2017**.

SECTION B. Implementation of project activity

B.1. Description of implemented registered project activity

This is the 2nd monitoring report for the project "Nubika Jaya Biogas Extraction for Bio-Hydrogen production" (UNFCCC Ref No. 2421), which covers the period of 01/08/2010 to 31/07/2012.

The CDM project implemented by NUBIKA reduces GHG emissions by a combination of methane avoidance from palm oil mill effluent currently treated in existing lagoon system and displacement of LPG with biogas for fuel and feedstock in hydrogen production process.

The CDM project itself consists of only one site and it is not a phased implementation.

The project was fully commissioned in early 2009 and it has been in operation since then. The CDM biogas equipment solution was provided by Endress+Hauser and commissioned in 04/2010.

During the 2nd monitoring period, NUBIKA has continuously strived to reduce the moisture in biogas such that it is suitable for use as feedstock in hydrogen production. The challenges are enormous as this is one of the first oleochemical plants to produce hydrogen from biogas, and therefore there is no reference plant currently available. Eventually, NUBIKA succeeded in injecting biogas as the feedstock for hydrogen production and the plant has been operated since April 2012.

To reduce the risk of data loss during off-site calibration, NUBIKA has also purchased additional back-up monitoring equipments (such as flowmeters), such that the data loss due to the inavailability of equipment may be minimized.

In terms of monitoring data, NUBIKA has also improved the data sheet format of biogas journal such that the monitoring data of biogas flows are all done hourly. This action is taken to reduce the calculation errors when transferring the data from the journal into the computerized format.

NUBIKA has also put continuous efforts to improve its biogas plant's efficiency to produce more biogas, which in turn will result in improved accuracy of monitoring of biogas recovered from Anaerobic Digester. NUBIKA has invited the technology provider of AD (Aquarius Systems Malaysia) in early 2012 to study the cause of the low efficiency, though the result is still not improved yet. In terms of accuracy of flowmeter, NUBIKA has also replaced the flowmeter F-01 with the backup set to improve the accuracy. It is expected that the progress for improvement of plant's efficiency and monitoring of biogas recovered to be a long term effort requiring cooperation from both internal team and the technology provider.

Finally, during the monitoring period 01/08/2010 – 31/07/2012, many troubles occurred during the project operations and shutdowns in the plant due to maintenance in oleochemical factory and long holidays. As a result, the plant was not running in full operation.

B.2. Post registration changes

B.2.1. Temporary deviations from registered monitoring plan or applied methodology

Not Applicable

B.2.2. Corrections

Not Applicable

B.2.3. Permanent changes from registered monitoring plan or applied methodology

Request for changes from registered monitoring plan or applied methodology has been addressed in the 1st Monitoring Period. The Change in Monitoring Plan is done on the following areas, which consist of:

1. Addition of monitoring parameters $Q_{y,ww}$, $COD_{y,ww,untreated}$, $COD_{y,ww,treated\_AD}$, $COD_{y,ww,treated}$, $COD_{y,ww,removed,i}$, $COD_{y,removed,j}$, $S_{y,final}$, and End use of the final sludge, which are necessary to evaluate/calculate project emissions as per Para 34 of AMS-III.H (version 09);

2. Revision of the Analysis frequency of LPG molar composition (m_1 and m_2) from "at least annually" to "every quarter" in order to meet the requirement of AMS-III.O (version 01);

3. Consideration of project emissions from emergency use of diesel generators;

4. Revision of description of CDM monitoring organization and recording form to reflect the actual monitoring activity.
   Under Management System and QA/QC in the registered PDD, the personnel who reports directly to Board of Director in parent company Permata Hijau Group is CDM Coordinator while in actual, the person reporting to Board of Director is CDM Manager, which adds one layer of reporting.

This request for revision of monitoring plan has been approved by CDM Executive Board on 19/07/2011.

B.2.4. Changes to project design of registered project activity

Change to project design of registered project activity has been addressed in the 1st Monitoring Period. The change from the project activity is that sulfur removal system for the purification of biogas used for hydrogen production is mistakenly described as Pressure Swing Adsorption (PSA) in the registered PDD (version 3.4.2). In actual situation, the hydrogen production system consists of H_2S removal units and modular hydrogen plant with PSA technology to produce high purity hydrogen from biogas.

The H_2S removal system is designed to reduce the contents of H_2S in the biogas such that it is suitable to be used as feedstock for hydrogen production. The system is a combination of wet and dry processes and air dryer. Air dryer will be used to reduce moisture in biogas to maintain H_2S removal efficiency of dry process.

The hydrogen production technology is a Hydro-chem process licensed by German-based Linde AG with a modular hydrogen plant as a base system. The PSA system is installed downstream of the hydrogen production plant to remove impurities such as CO, CO_2, CH_4, and H_2O from reformed gas for the production of high purity hydrogen.

This notification of changes from the project activity has been approved by CDM Executive Board on 19/07/2011.

B.2.5. Changes to start date of crediting period

The start date of the project activity is originally the registration date of the project on 30/06/2009. But due to the delay in the procurement of project's monitoring equipment, NUBIKA has requested post-registration change to the start date of the crediting period from 01/05/2010 as reflected in the UNFCCC CDM project data[1].

B.2.6. Types of changes specific to afforestation or reforestation project activity

Not Applicable

[1] http://cdm.unfccc.int/Projects/DB/JQA1236041272.55/view

SECTION C. Description of monitoring system

In order to meet the requirement of revised monitoring plan stated in the PDD, NUBIKA has created its CDM Monitoring team. A Standard Operational Procedure (SOP) has been developed in this aspect, which regulates the CDM monitoring program of the project and the roles and steps to be done by each member of the monitoring team. The organizational structure of CDM Monitoring team is shown in **Figure 1** as follows:

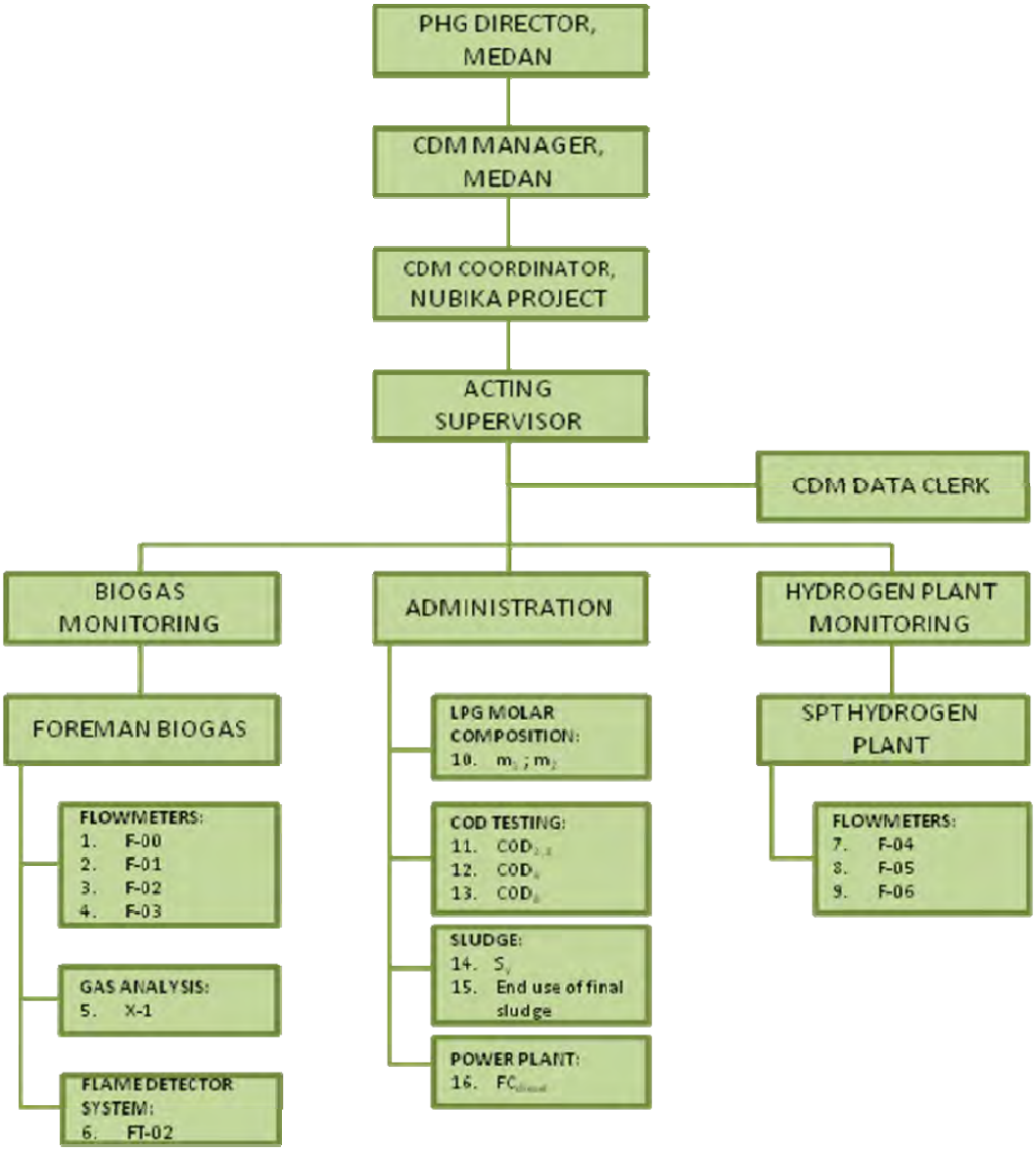


Figure 1 Organizational Structure of NUBIKA CDM monitoring team

NUBIKA appointed a CDM Manager who reports directly to Board of Director at its parent company, Permata Hijau Group. The CDM Manager coordinates the following activities:

1) Data collection and instrument calibration by NUBIKA's technical department,
2) Consolidation of results from various departments on monthly basis,
3) Issuance of emission reduction and monitoring reports for purpose of verification

Monitoring Structure

During the monitoring program, the structure and contents of the report consist of the following as illustrated in **Figure 2**:

1) Site Monitoring Journals; made by the Operators, authorized by Biogas and Hydrogen plant Superintendents, and reported to CDM Supervisor
2) Daily Report and Consolidated Monthly report; made by CDM Supervisor, confirmed by CDM Coordinator in NUBIKA, and reported to CDM Manager
3) Monitoring Report; prepared by CDM Manager and approved by PHG Board of Director

Site monitoring by the CDM Operators is conducted daily and encompasses all the required parameters for the revised monitoring plan as described in Section D.2.

CDM Supervisor is responsible to create Daily and Monthly Consolidated reports with contents as follows:
Daily Report is the consolidated operational data which has been processed to become data which can be used to calculate emission reductions for CDM purpose. From daily report, amount of baseline emissions can be known.
Consolidated Monthly Report. At the end of each month, CDM Supervisor consolidates all daily report and monthly journals to become Consolidated Monthly Report. From this report, month-by-month emission reductions can be known.

At the end of each monitoring period, the CDM Manager is responsible to prepare official report on emission reduction which has been achieved in the Monitoring Report and to be approved by PHG Board of Director.

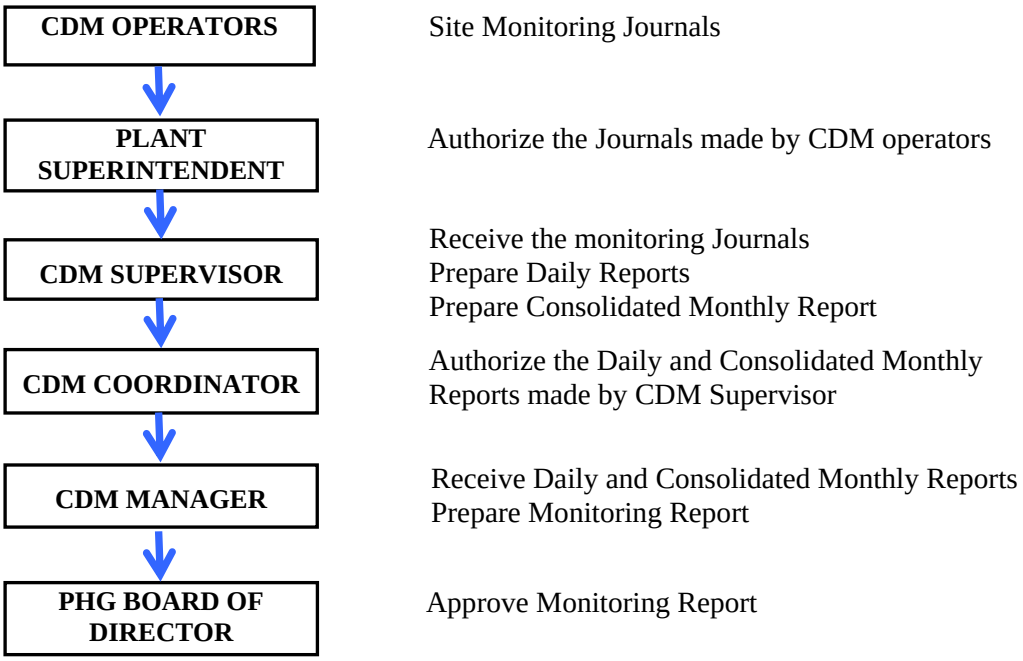


Figure 2 Reporting Structure for each CDM monitoring team

Data Archiving

To maintain existence of data and prevent lost of data, the operational data is stored in both hard copy and electronic (soft) copy. The electronic copy is sent to PHG headquarters in Medan on weekly basis to prevent data loss.

- Hard copies of data is stored in NUBIKA CDM Project office on-site
- Soft copies is stored in both NUBIKA office on-site and PHG headquarters in Medan

Both electronic and hard copy will be archived for at least 2 years after the end of the last crediting period.

Emergency Procedures

NUBIKA has established procedures for both biogas and hydrogen plant in the case of emergency situation. The emergency procedures cover the following emergency situations:

1. In Biogas plant
   Detailed procedures in case of a) Fire, b) Gas pipe leakage, c) Flare irregularities, d) gas coming out from water trap, e) irregular safety valve, f) blower tripped during operation of desulfurization, g) when feed is off operation, h) overflow in the tank, i) when CDM monitoring panel is shut down, and j) during power outage in the biogas plant

2. In Hydrogen plant
   Procedures for emergency shutdown for all the equipments (compressors, pumps) during irregular operation

Monitoring Points

The location of monitoring equipments is as shown in **Figure 3** below:

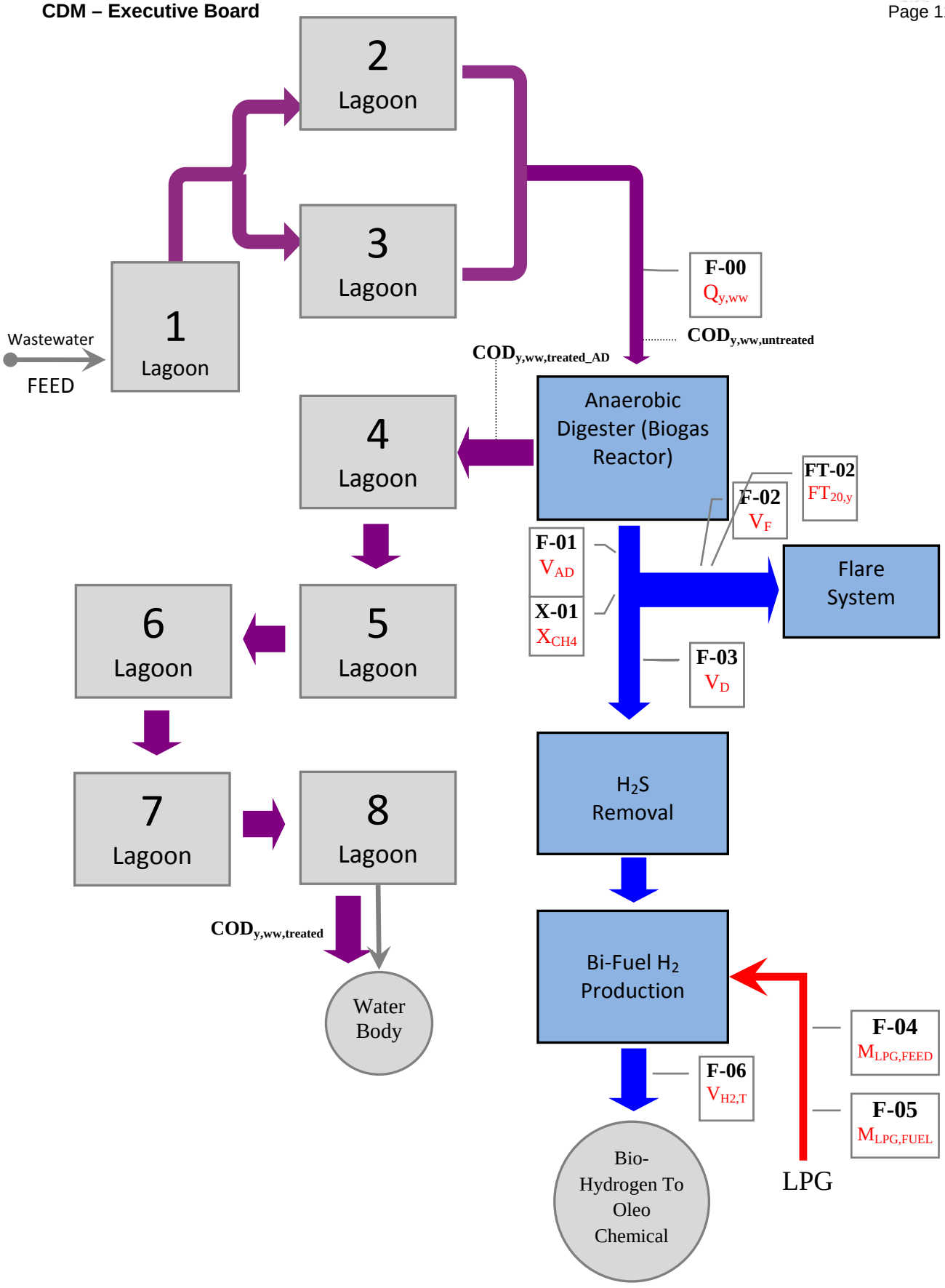


Figure 3 Diagram of Monitoring Points for the Project

SECTION D. Data and parameters

D.1. Data and parameters fixed ex ante or at renewal of crediting period

Data/Parameter	P_N
Unit	Pressure in Pascal (Pa)
Description	Reference pressure (P) at normal (N) condition as adopted by the volume measurement device
Source of data	IUPAC (present) definition
Value(s) applied	10^5
Purpose of data	Baseline emission calculations
Additional comment	N/A

Data/Parameter	T_N
Unit	Temperature in Kelvin (K)
Description	Reference temperature (T) at normal (N) condition as adopted by the volume measurement device
Source of data	IUPAC (present) definition
Value(s) applied	**273.15**
Purpose of data	Baseline emission calculations
Additional comment	N/A

Data/Parameter	**R**
Unit	$m^3.Pa.mol^{-1}.K^{-1}$
Description	Ideal gas constant in SI Unit
Source of data	Standard engineering literature
Value(s) applied	**8.314**
Purpose of data	Baseline emission calculations
Additional comment	Standard thermodynamic application values

Data/Parameter	GWP_{CH4}
Unit	tCO_2e /tCH_4
Description	Global warming potential of methane
Source of data	IPCC Data
Value(s) applied	**21**
Purpose of data	Baseline emission calculations
Additional comment	To be updated with re-issuance of latest IPCC report

Data/Parameter	SFC_{LPG}
Unit	$kgLPG/Nm^3H_2$
Description	Specific fuel consumption of the hydrogen production unit using LPG as fuel
Source of data	Manufacturer's specification
Value(s) applied	**0.1**
Purpose of data	Baseline emission calculations
Additional comment	As prescribed in p.15 of AMS. III-O, this value is applicable if the hydrogen production unit is never operated using LPG to allow for measurement within the credit period.

Data/Parameter	MW_{CO2}; MW_{C3H8}; MW_{C4H10}; MW_{CH4}
Unit	g/mol
Description	Molecular weight of CO_2, C_3H_8, C_4H_{10} , and CH_4 respectively
Source of data	Standard chemistry literature
Value(s) applied	MW_{CO2} : **44** MW_{C3H8}: **44** MW_{C4H10}: **58** MW_{CH4} : **16**
Purpose of data	Baseline emission calculations
Additional comment	Standard values

Data/Parameter	$EF_{CO2,Diesel}$
Unit	tCO_2/TJ
Description	CO_2 emission factor of Diesel
Source of data	2006 IPCC Guidelines for Energy
Value(s) applied	**74.8**
Purpose of data	Project emission calculations
Additional comment	As provided in 2006 IPCC Guideline. Table 1.4 upper value of the 95% confidence interval is used.

Data/Parameter	NCV_{Diesel}
Unit	TJ/Gg
Description	Net calorific value of Diesel
Source of data	2006 IPCC Guidelines for Energy
Value(s) applied	**43.3**
Purpose of data	Project emission calculations
Additional comment	As provided in 2006 IPCC Guideline (upper value of the 95% confidence interval is used.)

D.2. Data and parameters monitored

Data/Parameter	**m_1; m_2**
Unit	**%**
Description	Molar composition of propane and butane in LPG used in hydrogen plant
Measured/Calculated /Default	Measured
Source of data	Certificate of Quality from PERTAMINA (LPG Supplier)
Value(s) of monitored parameter	**m_1: 53.14** **m_2: 46.64**
Monitoring equipment	N/A
Measuring/Reading/ Recording frequency	Quarterly
Calculation method (if applicable)	N/A
QA/QC procedures	If values are based on sampling, analysis must be performed by an accredited laboratory. Certificate of Quality issued by PERTAMINA Laboratory – Tanjung Uban Installation Region I Report No: 0141/L/LPG/2010 Test Date: 31/10/2010
Purpose of data	Baseline emission calculations
Additional comment	N/A

Data/Parameter	**EF_{LPG}**
Unit	**$kgCO_2$ / kg LPG**
Description	CO_2 emission factor from combustion of LPG
Measured/Calculated /Default	Calculated
Source of data	Based on LPG molar composition
Value(s) of monitored parameter	**3.018**
Monitoring equipment	N/A
Measuring/Reading/ Recording frequency	Quarterly
Calculation method (if applicable)	1. Estimate carbon content of LPG (C_{LPG} in kgC/kgLPG) based on parameter m_1, m_2 2. Calculate emission factor using the following formula: $EF_{LPG} = C_{LPG} \times 44\ kgCO_2 / 12\ kgC$
QA/QC procedures	See QA/QC procedure for parameter m_1 and m_2
Purpose of data	Baseline emission calculations
Additional comment	N/A

Data/Parameter	**$M_{LPG\ FEED}$**
Unit	**kg**
Description	Amount of LPG used as reaction feedstock
Measured/Calculated /Default	Measured
Source of data	Flow rate of LPG to reformer feed (F-04) in Daily Hydrogen Journal (NBK-J2)
Value(s) of monitored parameter	**1,433,580.56**
Monitoring equipment	Type: Flow meter Siemens SITRANS 7MF4433-1EA22-1NC7-Z Accuracy: < 0.55% (EN60770-1) Serial Number: N1-X622-9087676 Calibration frequency: Every year Date of last calibration: 04/04/2011 Validity: 04/04/2011 – 03/04/2012
Measuring/Reading/ Recording frequency	Continuous measurement when the unit is operated using LPG; Logged manually on hourly basis
Calculation method (if applicable)	Volumetric unit is converted to the mass unit using LPG density.
QA/QC procedures	Flow meter is calibrated by a third party certified laboratory (ISO/IEC17025 certified) Uncertainty: Error level of maximum 4%
Purpose of data	Baseline emission calculations
Additional comment	N/A

Data/Parameter	**$M_{LPG\ FUEL}$**
Unit	**kg**
Description	Amount of LPG used as fuel to reformer
Measured/Calculated /Default	Measured
Source of data	Flow rate of LPG to reformer burner (F-05) in Daily Hydrogen Journal (NBK-J2)
Value(s) of monitored parameter	**0** (not operated during the monitoring period)
Monitoring equipment	Type: Flow meter Siemens SITRANS 7MF4433-1EA22-1NC7-Z Accuracy: <0.55% (EN60770-1) Serial Number: 1X-V009-9037948 Calibration frequency: Every year Date of last calibration: 07/11/2011 Validity: 07/11/2011 – 06/11/2012
Measuring/Reading/ Recording frequency	Continuous measurement when the unit is operated using LPG; Logged manually on hourly basis
Calculation method (if applicable)	Volumetric unit is converted to the mass unit using LPG density.
QA/QC procedures	Flow meter is calibrated by a third party certified laboratory (ISO/IEC17025 certified) Uncertainty: Error level of maximum 4%
Purpose of data	Baseline emission calculations
Additional comment	N/A

Data/Parameter	**X_{CH4}**
Unit	**%**
Description	Concentration of methane in the biogas on volumetric basis
Measured/Calculated /Default	Measured
Source of data	Records (in average) of Gas Analysis Device (X-01) in Daily Biogas Journal (NBK-J1)
Value(s) of monitored parameter	**66.32**
Monitoring equipment	Type: AwiFlex Series 7 Accuracy: ±2% (Manufacturer's specification) Serial Number: 670_09 Calibration frequency: Every year Date of last calibration: 11/01/2012 Validity: 11/01/2012 – 10/01/2013
Measuring/Reading/ Recording frequency	Continuous measurement; Logged manually on hourly basis
Calculation method (if applicable)	N/A
QA/QC procedures	Instrument is calibrated by a certified third party (ISO/IEC17025 certified). Uncertainty: Error level of maximum 5%.
Purpose of data	Baseline emission calculations
Additional comment	N/A

Data/Parameter	**$FT_{20,y}$**
Unit	**Hours**
Description	The number of hours in the monitoring period, of which the flame is detected for more than 20 minutes in an hour
Measured/Calculated /Default	Measured
Source of data	Records for Flame detection system (FT-02) in Daily Biogas Journal (NBK-J1)
Value(s) of monitored parameter	**8,084**
Monitoring equipment	Model: TAF11-99ACX3F1D0 Accuracy: Tolerance Class 2 IEC584 Serial Number: CC0001141D5 Frequency: Every year Date of last check: 23/12/2010 Validity: 23/12/2010 – 22/12/2011
Measuring/Reading/ Recording frequency	Continuous monitoring; Logged manually on hourly basis
Calculation method (if applicable)	N/A
QA/QC procedures	Flame detection instrument is checked and tested for at least once a year.
Purpose of data	Project emission calculations
Additional comment	N/A

Data/Parameter	**V_{AD}**
Unit	**Nm^3**
Description	The amount of biogas recovered from anaerobic digester
Measured/Calculated /Default	Measured
Source of data	Records for Gas flow meter at Anaerobic Digester outlet (F-01) in Daily Biogas Journal (NBK-J1)
Value(s) of monitored parameter	**2,218,330.61**
Monitoring equipment	Type: E+H PROWIRL 72F1F-SE0BA12AA4AW Accuracy: <1% (ISO/DIN 11631) Serial Number: E7048E02000 Calibration frequency: Every year Date of last calibration: 14/07/2011 Validity: 14/07/2011 – 13/07/2012
Measuring/Reading/ Recording frequency	Continuous measurement; Logged manually on daily basis
Calculation method (if applicable)	N/A
QA/QC procedures	Instrument is calibrated by an ISO/IEC17025 accredited third party . Uncertainty: Error level of maximum 4% (as per registered PDD).
Purpose of data	Leakage emission calculations
Additional comment	N/A

Data/Parameter	**V_D**
Unit	**Nm^3**
Description	The amount of biogas used for hydrogen production
Measured/Calculated /Default	Measured
Source of data	Records for Gas flow meter at the pipeline to hydrogen production inlet (F-03) in Daily Biogas Journal (NBK-J1)
Value(s) of monitored parameter	**1,652,823.38**
Monitoring equipment	Type: E+H PROWIRL 72F1H-SE0AA1AAA4AA Accuracy: <1% (ISO/DIN 11631) Serial Number: 99005120000 Calibration frequency: Every year Date of last calibration: 14/10/2011 Validity: 14/10/2011 – 13/10/2012
Measuring/Reading/ Recording frequency	Continuous measurement; Logged manually on daily basis
Calculation method (if applicable)	N/A
QA/QC procedures	Instrument is calibrated by an ISO/IEC17025 accredited third party. Uncertainty: Error level of maximum 4% (as per registered PDD).
Purpose of data	Baseline and Leakage emission calculations
Additional comment	N/A

Data/Parameter	**V_F**
Unit	**Nm^3**
Description	The amount of biogas flared
Measured/Calculated /Default	Measured
Source of data	Records for Gas flow meter at flare inlet (F-02) in Daily Biogas Journal (NBK-J1)
Value(s) of monitored parameter	**1,173,783.60**
Monitoring equipment	Type: E+H PROWIRL 72F1H-SE0AA1AAA4AA Accuracy: <1% (ISO/DIN 11631) Serial Number: A901BF02000 Calibration frequency: Every year Date of last calibration: 14/10/2011 Validity: 14/10/2011 – 13/10/2012
Measuring/Reading/ Recording frequency	Continuous measurement; Logged manually on hourly basis
Calculation method (if applicable)	N/A
QA/QC procedures	Instrument is calibrated by an ISO/IEC17025 accredited third party. Uncertainty: Error level of maximum 4% (as per registered PDD).
Purpose of data	Baseline and Leakage emission calculations
Additional comment	N/A

Data/Parameter	**$V_{H2,T}$**
Unit	**Nm^3**
Description	Total volumetric amount of hydrogen produced
Measured/Calculated /Default	Measured
Source of data	Records of Flow meter F-06 in Daily Hydrogen Journal (NBK-J2)
Value(s) of monitored parameter	**5,015,071.80**
Monitoring equipment	Type: Flow meter Siemens SITRANS 7MF4433-1EA22-1NC7-Z Accuracy: <0.55% (EN60770-1) Serial Number: N1-BN08-9078867 Calibration frequency: Every year Date of last calibration: 15/11/2011 Validity: 15/11/2011 – 14/11/2012
Measuring/Reading/ Recording frequency	Continuous measurement; Logged manually on hourly basis
Calculation method (if applicable)	N/A
QA/QC procedures	Instrument is calibrated by an ISO/IEC17025 accredited third party. Uncertainty: Error level of maximum 4% (as per registered PDD).
Purpose of data	Baseline emission calculations
Additional comment	N/A

Data/Parameter	**$Q_{y,ww}$**
Unit	**m^3**
Description	Volume of wastewater treated
Measured/Calculated /Default	Measured
Source of data	Records of Flow meter F-00 in Daily Biogas Journal (NBK-J1)
Value(s) of monitored parameter	**398,785.10**
Monitoring equipment	Type: E+H PROMAG 10W80–SCOA1AAOA4AA Accuracy: 0.5 % (DIN29104) Serial Number: 99005320000 Calibration frequency: at least once in three years Date of last calibration: 18/09/2007 Validity: 18/09/2007 – 17/09/2010 Serial Number: EA166719000 Calibration frequency: Every 2 years Date of last calibration: 03/11/2011 Validity: 03/11/2011 – 02/11/2013
Measuring/Reading/ Recording frequency	Continuous measurement; Logged manually on daily basis
Calculation method (if applicable)	N/A
QA/QC procedures	Instrument is calibrated by a third party certified laboratory (ISO/IEC17025 certified) Uncertainty: Error level of maximum 4%
Purpose of data	Project emission calculations
Additional comment	N/A

Data/Parameter	**$COD_{y,ww,untreated}$**
Unit	**tonnes / m^3**
Description	Chemical oxygen demand of the wastewater entering the anaerobic digester system
Measured/Calculated /Default	Measured
Source of data	COD analysis by NUBIKA
Value(s) of monitored parameter	**0.0482**
Monitoring equipment	Type: Genesys 10UV Scanning Spectrophotometer Accuracy (Photometric): 0.5% (Manufacturer's specification) Serial Number: 2M1L149001 Calibration frequency: at least once in three years Date of calibration: 29/05/2008 Validity: 29/05/2008 – 28/05/2011 Date of last calibration: 19/12/2011 Validity: 19/12/2011 – 18/12/2014
Measuring/Reading/ Recording frequency	Monthly
Calculation method (if applicable)	N/A
QA/QC procedures	The analysis is conducted in accordance with Method 5220D of Standard Method, closed reflux method for COD analysis.
Purpose of data	Project emission calculations
Additional comment	N/A

Data/Parameter	**$COD_{y,ww,treated\ AD}$**
Unit	**tonnes / m^3**
Description	Chemical oxygen demand of the treated wastewater out from the anaerobic digester system into the existing lagoon system
Measured/Calculated /Default	Measured
Source of data	COD analysis by NUBIKA
Value(s) of monitored parameter	**0.0117**
Monitoring equipment	Type: Genesys 10UV Scanning Spectrophotometer Accuracy (Photometric): 0.5% (Manufacturer's specification) Serial Number: 2M1L149001 Calibration frequency: at least once in three years Date of calibration: 29/05/2008 Validity: 29/05/2008 – 28/05/2011 Date of last calibration: 19/12/2011 Validity: 19/12/2011 – 18/12/2014
Measuring/Reading/ Recording frequency	Monthly
Calculation method (if applicable)	N/A
QA/QC procedures	The analysis is conducted in accordance with Method 5220D of Standard Method, closed reflux method for COD analysis.
Purpose of data	Project emission calculations
Additional comment	N/A

Data/Parameter	**$COD_{y,ww,treated}$**
Unit	**tonnes / m^3**
Description	Chemical oxygen demand of the final treated wastewater discharged into sea, river, or lake
Measured/Calculated /Default	Measured
Source of data	COD analysis by NUBIKA
Value(s) of monitored parameter	**0.0002**
Monitoring equipment	Type: Genesys 10UV Scanning Spectrophotometer Accuracy (Photometric): 0.5% (Manufacturer's specification) Serial Number: 2M1L149001 Calibration frequency: at least once in three years Date of calibration: 29/05/2008 Validity: 29/05/2008 – 28/05/2011 Date of last calibration: 19/12/2011 Validity: 19/12/2011 – 18/12/2014
Measuring/Reading/ Recording frequency	Monthly
Calculation method (if applicable)	N/A
QA/QC procedures	The analysis is conducted in accordance with Method 5220D of Standard Method, closed reflux method for COD analysis.
Purpose of data	Project emission calculations
Additional comment	N/A

Data/Parameter	**$COD_{y,removed,i}$**
Unit	**tonnes / m^3**
Description	Chemical oxygen demand removed by the anaerobic wastewater treatment systems *i* in the baseline situation to which the sequential anaerobic treatment step is being introduced. For the project activity treatment system *i* is the open lagoon system
Measured/Calculated /Default	Calculated
Source of data	Based on COD sampling and analysis of COD (**$COD_{y,ww,untreated}$** and **$COD_{y,ww,treated}$**)
Value(s) of monitored parameter	**0.0480**
Monitoring equipment	N/A
Measuring/Reading/ Recording frequency	N/A
Calculation method (if applicable)	In accordance with AMS-III.H version 9, this is determined by subtracting $COD_{y,ww,treated}$ from $COD_{y,ww,untreated}$ $COD_{y,removed,openlagoon} = COD_{y,ww,untreated} - COD_{y,ww,treated}$
QA/QC procedures	N/A
Purpose of data	Project emission calculations
Additional comment	N/A

Data/Parameter	**$COD_{y,removed,j}$**
Unit	**tonnes / m^3**
Description	Chemical oxygen demand removed by the treatment systems *j* of the project activity equipped with methane recovery. For the project activity treatment system *j* is the anaerobic digester system
Measured/Calculated /Default	Calculated
Source of data	Based on COD sampling and analysis of COD (**$COD_{y,ww,untreated}$** and **$COD_{y,ww,treated\_AD}$**)
Value(s) of monitored parameter	**0.0365**
Monitoring equipment	N/A
Measuring/Reading/ Recording frequency	N/A
Calculation method (if applicable)	In accordance with AMS-III.H version 9, this is determined by subtracting $COD_{y,ww,treated\_AD}$ from $COD_{y,ww,untreated}$, which is recorded every quarterly $COD_{y,removed,AD} = COD_{y,ww,untreated} - COD_{y,ww,treated\ AD}$
QA/QC procedures	N/A
Purpose of data	Project emission calculations
Additional comment	N/A

Data/Parameter	**$S_{y,final}$**
Unit	**tonnes**
Description	Amount of final sludge generated by the wastewater treatment
Measured/Calculated /Default	Measured
Source of data	On-site recording by NUBIKA
Value(s) of monitored parameter	**0** (Final sludge was not removed in the 2nd monitoring period)
Monitoring equipment	Weighing Bridge Type: WE 9000 N Accuracy: Class III Serial Number: 000035N Calibration frequency: Every year Date of calibration: July 2010 Validity: July 2010 – July 2011 Date of last calibration: July 2011 Validity: July 2011 – July 2012
Measuring/Reading/ Recording frequency	Amount of sludge generated by the wastewater treatment will be measured every time when sludge is removed from the wastewater treatment system
Calculation method (if applicable)	N/A
QA/QC procedures	Government Decree No. 2, 1989 concerning National Standards for Measurement Units
Purpose of data	Project emission calculations
Additional comment	N/A

Data/Parameter	**End use of final sludge**
Unit	N/A
Description	Details of end-use/disposal of removed sludge
Measured/Calculated /Default	N/A
Source of data	On-site recording by NUBIKA
Value(s) of monitored parameter	Final sludge was not removed in the 2nd monitoring period
Monitoring equipment	N/A
Measuring/Reading/ Recording frequency	End use of final sludge will be monitored and recorded every time when sludge is removed from the wastewater treatment system
Calculation method (if applicable)	N/A
QA/QC procedures	End-use/disposal records, if any, will be made available to DOE at the time of verification.
Purpose of data	Project emission calculations
Additional comment	N/A

Data/Parameter	**FC_{Diesel}**
Unit	**Litres**
Description	Amount of diesel oil consumed by the project activity
Measured/Calculated /Default	Measured
Source of data	On-site record by Nubika Monthly Consumption Records for Power Station data
Value(s) of monitored parameter	**29,816.43**
Monitoring equipment	Type: GASBOY Series 4860-9S Accuracy: ±0.5% (Manufacturer's specification) Serial Number: 00560 Calibration frequency: Every 2 years Date of last calibration: 20/12/2009 Validity: 20/12/2009 – 19/12/2011
Measuring/Reading/ Recording frequency	Logged manually in power station data on monthly basis
Calculation method (if applicable)	Small amount of Diesel may be consumed as backup fuel for the existing biomass power generating facility. Only the fraction of electricity consumed by the project activity will be accounted as the project emission. The fraction of electricity consumed by the project activity will be determined based on the power consumption record of Nubika.
QA/QC procedures	N/A
Purpose of data	Project emission calculations
Additional comment	N/A

D.3. Implementation of sampling plan

Not Applicable

SECTION E. Calculation of emission reductions or GHG removals by sinks

All of the GHG emission reduction calculation formula / equation are in accordance with the registered PDD version 4.1.0.

E.1. Calculation of baseline emissions or baseline net GHG removals by sinks

E.1.1. Baseline Emissions from methane recovery

The baseline emissions from methane recovery by the project activity are calculated based on the methane recovered, fuelled, or flared that is monitored ex-post. Consequently, in the project situation, the baseline emission is calculated based on volumetric measurements of biogas that is (a) used for hydrogen production and (b) flared.

The baseline emission for methane recovery is calculated using equation below:

$$BE_{y,CH4} = X_{CH4,y} \times \frac{P_N * V_{TR,y}}{R * T_N} \times \frac{MW_{CH4}}{X_1} \times GWP_{CH4}$$

Parameter	Description	Unit
$BE_{y,CH4}$	Baseline emission from methane recovery in year y	tCO_2/yr
$X_{CH4,y}$	Proportion of methane in biogas in volume/volume basis	Nm^3/Nm^3
P_N	Reference pressure at normal condition in Pascal	Pa
$V_{TR,y}$	Volumetric amount of biogas recovered	Nm^3/yr
R	Ideal gas constant, 8.314	$m^3.Pa/mol.K$
T_N	Reference temperature at Normal condition in Kelvin	K
MW_{CH4}	Molecular weight of methane	gram/mol
X_1	Conversion factor 10^6 grams/tones	gram/ton
GWP_{CH4}	Global warming potential of methane	tCO_2/tCH_4

The amount of methane recovered is calculated as the sum of all biogas delivered to various utilizations in the project.

$V_{TR,y} = V_{D,y} + V_{F,y}$

Parameter	Description	Unit
$V_{TR,y}$	Total volumetric amount of biogas recovered from the Project	Nm^3/yr
$V_{D,y}$	Volumetric amount of biogas used in H_2 production	Nm^3/yr
$V_{F,y}$	Volumetric amount of biogas flared	Nm^3/yr

The result is tabulated in the following **Table 1**.

Table 1 Calculation of Baseline Emission from Methane Recovery

Month	Source of Report	V_D	V_F	V_{TR}	X_{CH4}	BE_{CH4}
		N m^3	N m^3	N m^3	%	tCO_2 e
Aug 2010	NUB-L3/1008	63,891.70	40,764.40	104,656.10	71.21%	1,102
Sep 2010	NUB-L3/1009	34,354.70	20,809.30	55,164.00	69.06%	563
Oct 2010	NUB-L3/1010	104,704.00	12,524.60	117,228.60	69.20%	1,200
Nov 2010	NUB-L3/1011	54,399.60	12,192.10	66,591.70	70.05%	690
Dec 2010	NUB-L3/1012	95,323.60	2,722.40	98,046.00	69.13%	1,002
Jan 2011	NUB-L3/1101	64,363.88	8,930.00	73,293.88	66.90%	725
Feb 2011	NUB-L3/1102	46,579.10	16,390.30	62,969.40	64.13%	597
Mar 2011	NUB-L3/1103	117,393.70	22,081.70	139,475.40	70.76%	1,460
Apr 2011	NUB-L3/1104	20,199.60	20,758.50	40,958.10	71.03%	430
May 2011	NUB-L3/1105	6,288.50	35,804.60	42,093.10	70.50%	439
Jun 2011	NUB-L3/1106	98,872.90	4,045.30	102,918.20	64.98%	989
Jul 2011	NUB-L3/1107	88,337.60	47,682.80	136,020.40	59.98%	1,207
Aug 2011	NUB-L3/1108	49,953.10	30,288.40	80,241.50	60.87%	722
Sep 2011	NUB-L3/1109	89,954.60	51,226.00	141,180.60	62.56%	1,306
Oct 2011	NUB-L3/1110	114,614.20	83,667.20	198,281.40	60.26%	1,767
Nov 2011	NUB-L3/1111	110,545.00	44,311.00	154,856.00	59.94%	1,373
Dec 2011	NUB-L3/1112	126,973.30	53,099.40	180,072.70	60.35%	1,607
Jan 2012	NUB-L3/1201	117,613.00	69,646.70	187,259.70	63.82%	1,768
Feb 2012	NUB-L3/1202	88,274.30	77,732.00	166,006.30	67.38%	1,654
Mar 2012	NUB-L3/1203	60,817.70	28,818.90	89,636.60	69.73%	924
Apr 2012	NUB-L3/1204	27,549.10	85,713.90	113,263.00	68.98%	1,156
May 2012	NUB-L3/1205	5,998.70	107,339.20	113,337.90	70.07%	1,174
Jun 2012	NUB-L3/1206	6,824.30	150,994.80	157,819.10	68.07%	1,589
Jul 2012	NUB-L3/1207	58,997.20	146,240.10	205,237.30	62.80%	1,906
	Total / *Average*	**1,652,823.38**	**1,173,783.60**	**2,826,606.98**	*66.32%*	**27,350**

E.1.2. Baseline Emissions from displacement of LPG feedstock in the hydrogen production unit

The baseline emissions from reactions of LPG used for feedstock are calculated based on the molar amount of hydrogen generated from biogas and the CO_2 generation potential of the baseline fuel (LPG).

$$BE_{LPG,FEED} = R_{CO2/H2} \times m_{H2,BIO} \times MW_{CO2} \times C_1$$

Parameter	Description	Unit
$BE_{LPG,FEED}$	Baseline CO_2 emission from the reaction of displaced LPG feedstock in the hydrogen production unit	tCO_2
$R_{CO2/H2}$	CO_2 generation potential	$kmolCO_2$/ $kmolH_2$
$m_{H2,BIO}$	Molar quantity of hydrogen produced from biogas	$kmolH_2$/yr
MW_{CO2}	Molecular weight of CO_2 ,44kg/kmol	$kgCO_2$/ $kmolCO_2$
C_1	Conversion factor tonne/kg, 10^{-3}tonne/kg	$tCO_2/kgCO_2$

Determination of $R_{CO2/H2}$

The calculation of CO_2 generation potential is based on the molar analysis of the LPG as follows:

$$R_{CO2/H2} = \frac{[3m_1 + 4m_2]}{[10m_1 + 13m_2]}$$

Parameter	Description	Unit
$R_{CO2/H2}$	CO_2 generation potential from the reaction of LPG as feedstock	unitless
m_1	%mol of the propane in the LPG	molC_3H_8/molLPG
m_2	%mol of the butane in the LPG	molC_4H_{10}/molLPG

Determination of Hydrogen derived from biogas, $m_{H2,BIO}$

The molar amount of hydrogen derived from biogas is calculated as the difference between the total molar amount of hydrogen produced in the hydrogen production unit and the molar amount of hydrogen produced using LPG.

$m_{H2,BIO} = m_{H2,T} - m_{H2,LPG}$

Parameter	Description	Unit
$m_{H2,T}$	Total molar amount of hydrogen produced by hydrogen production unit	kmolH_2/yr
$m_{H2,LPG}$	Molar amount of hydrogen derived from LPG	kmolH_2/yr
$m_{H2,BIO}$	Molar amount of hydrogen derived from biogas	kmolH_2/yr

The total hydrogen production is measured in the unit of NCMH (normalized m^3 per hour) and converted into its equivalent molar unit using ideal gas equation in normal condition.

$$m_{H2,T} = \frac{1\times10^5 Pa \times V_{H2,T}}{8.314\frac{Pa\cdot m^3}{mol\cdot K}\times 273.15K \times 1{,}000\frac{mol}{kmol}}$$

Parameter	Description	Unit
$V_{H2,T}$	Total volume of hydrogen produced in Normal volume	Nm^3/yr
$m_{H2,T}$	Equivalent molar quantity of total hydrogen produced	kmolH_2/yr

While the molar amount of hydrogen derived from LPG is calculated as follow:

$$m_{H2,LPG} = R_{H2/LPG} \times \frac{M_{LPG\_FEED}}{MW_{LPG}}$$

Parameter	Description	Unit
$M_{LPG\ FEED}$	Amount of LPG used as reaction feedstock in mass unit based on monitoring	kgLPG/yr
$R_{H2/LPG}$	H_2 generation potential	molH_2/molLPG

MW_{LPG}	Molecular weight of LPG	kgLPG/kmolLPG
$m_{H2,LPG}$	Molar amount of hydrogen derived from LPG	$kmolH_2/yr$

The molecular weight of LPG depends on the molar composition of its mixture, which contains m_1%mol of propane and m_2%mol of butane, and is calculated as weighted average of individual gas:

$MW_{LPG} = m_1\,\% \times 44 + m_2\,\% \times 58$

Finally, the hydrogen generation potential of LPG is calculated as follow:

$$R_{H2/LPG} = \frac{10m_1 + 13m_2}{100}$$

The result is tabulated in the following **Table 2**.

Table 2 Calculation of Baseline Emission from the displaced LPG feedstock in the H_2 production unit

Month	Source of Report	m_1	m_2	$V_{H2,T}$	$M_{LPG,FEED}$	$m_{H2,T}$	$m_{H2,LPG}$	$m_{H2,BIO}$	$BE_{LPG\ FEED}$
		%	%	Nm^3	kgLPG	$kmolH_2$	$kmolH_2$	$kmolH_2$	tCO_2e
Aug 2010	NUB-L3/1008	53.14%	46.64%	112,917.20	42,561.81	4,972.20	9,601.57	0.00	0
Sep 2010	NUB-L3/1009	53.14%	46.64%	95,779.20	41,004.09	4,217.55	9,250.16	0.00	0
Oct 2010	NUB-L3/1010	53.14%	46.64%	294,484.50	93,350.42	12,967.35	21,059.04	0.00	0
Nov 2010	NUB-L3/1011	53.14%	46.64%	134,527.10	63,224.63	5,923.78	14,262.93	0.00	0
Dec 2010	NUB-L3/1012	53.14%	46.64%	362,189.00	98,462.98	15,948.65	22,212.39	0.00	0
Jan 2011	NUB-L3/1101	53.14%	46.64%	295,272.00	76,864.44	13,002.03	17,339.95	0.00	0
Feb 2011	NUB-L3/1102	53.14%	46.64%	196,946.00	32,967.73	8,672.33	7,437.23	1,235.10	16
Mar 2011	NUB-L3/1103	53.14%	46.64%	365,178.00	105,871.71	16,080.27	23,883.73	0.00	0
Apr 2011	NUB-L3/1104	53.14%	46.64%	12,921.90	3,108.80	569.00	701.32	0.00	0
May 2011	NUB-L3/1105	53.14%	46.64%	8,411.20	5,971.66	370.38	1,347.16	0.00	0
Jun 2011	NUB-L3/1106	53.14%	46.64%	259,813.30	92,086.30	11,440.64	20,773.87	0.00	0
Jul 2011	NUB-L3/1107	53.14%	46.64%	302,013.20	104,988.48	13,298.87	23,684.49	0.00	0
Aug 2011	NUB-L3/1108	53.14%	46.64%	172,273.80	56,501.46	7,585.92	12,746.24	0.00	0
Sep 2011	NUB-L3/1109	53.14%	46.64%	97,590.10	36,000.52	4,297.29	8,121.40	0.00	0
Oct 2011	NUB-L3/1110	53.14%	46.64%	232,678.50	78,799.83	10,245.78	17,776.55	0.00	0
Nov 2011	NUB-L3/1111	53.14%	46.64%	254,723.20	86,981.38	11,216.50	19,622.24	0.00	0
Dec 2011	NUB-L3/1112	53.14%	46.64%	268,655.90	91,385.47	11,830.01	20,615.77	0.00	0
Jan 2012	NUB-L3/1201	53.14%	46.64%	251,012.30	96,825.63	11,053.09	21,843.02	0.00	0
Feb 2012	NUB-L3/1202	53.14%	46.64%	329,928.00	89,604.73	14,528.07	20,214.05	0.00	0
Mar 2012	NUB-L3/1203	53.14%	46.64%	122,760.40	39,695.53	5,405.64	8,954.97	0.00	0
Apr 2012	NUB-L3/1204	53.14%	46.64%	201,871.10	38,214.63	8,889.21	8,620.89	268.32	3
May 2012	NUB-L3/1205	53.14%	46.64%	197,742.10	59,108.32	8,707.39	13,334.32	0.00	0
Jun 2012	NUB-L3/1206	53.14%	46.64%	196,758.30	0.00	8,664.07	0.00	8,664.07	115
Jul 2012	NUB-L3/1207	53.14%	46.64%	248,625.50	0.00	10,947.99	0.00	10,947.99	146
Total				**5,015,071.80**	**1,433,580.56**	**220,834.00**	**323,403.28**	**21,115.48**	**280**

E.1.3. Baseline Emissions from combustion of LPG as fuel to reforming process

The baseline emissions from combustion of LPG used as fuel to reforming process is calculated as follows:
$BE_{LPG\_FUEL} = SFC_{LPG} * V_{H2,BIO} * EF_{LPG} * C_3$

Parameter	Description	Unit
SFC_{LPG}	Specific fuel consumption of hydrogen production unit when run using LPG	$kgLPG/Nm^3H_2$
$V_{H2,BIO}$	Volume of hydrogen derived from biogas	Nm^3H_2/yr
EF_{LPG}	Emission factor of LPG calculated based on its carbon content	$kgCO_2/kgLPG$
C_3	Conversion factor, t/kg, 0.001	t/1000kg
$BE_{LPG,FUEL}$	Baseline CO_2 emission from avoidance of LPG as fuel to reformer burner	tCO_2

The volumetric amount of hydrogen derived from biogas is calculated based on its molar volume, $m_{H2,BIO}$, using ideal gas relationship.

$$V_{H2,BIO} = \frac{m_{H2,BIO} \times 1{,}000 \frac{mol}{kmol} \times 8.314 \frac{Pa \cdot m^3}{mol \cdot K} \times 273.15K}{1 \times 10^5 Pa}$$

Parameter	Description	Unit
$m_{H2,BIO}$	Molar quantity of hydrogen produced from biogas	$kmolH_2/yr$
$V_{H2,BIO}$	Amount of hydrogen produced from biogas in volumetric unit	Nm^3H_2/yr

The result is tabulated in the following **Table 3**.

Table 3 Calculation of Baseline Emission from avoidance of LPG as fuel to reformer burner

Month	Source of Report	SFC_{LPG}	$V_{H2,BIO}$	$BE_{LPG,FUEL}$
		$kgLPG/Nm^3H_2$	$N\ m^3$	$tCO_2\ e$
Aug 2010	NUB-L3/1008	0.10	0.00	0
Sep 2010	NUB-L3/1009	0.10	0.00	0
Oct 2010	NUB-L3/1010	0.10	0.00	0
Nov 2010	NUB-L3/1011	0.10	0.00	0
Dec 2010	NUB-L3/1012	0.10	0.00	0
Jan 2011	NUB-L3/1101	0.10	0.00	0
Feb 2011	NUB-L3/1102	0.10	28,048.75	8
Mar 2011	NUB-L3/1103	0.10	0.00	0
Apr 2011	NUB-L3/1104	0.10	0.00	0
May 2011	NUB-L3/1105	0.10	0.00	0
Jun 2011	NUB-L3/1106	0.10	0.00	0
Aug 2011	NUB-L3/1108	0.10	0.00	0
Sep 2011	NUB-L3/1109	0.10	0.00	0
Oct 2011	NUB-L3/1110	0.10	0.00	0
Nov 2011	NUB-L3/1111	0.10	0.00	0
Dec 2011	NUB-L3/1112	0.10	0.00	0
Jan 2012	NUB-L3/1201	0.10	0.00	0
Feb 2012	NUB-L3/1202	0.10	0.00	0
Mar 2012	NUB-L3/1203	0.10	0.00	0
Apr 2012	NUB-L3/1204	0.10	6,093.41	1
May 2012	NUB-L3/1205	0.10	0.00	0

Jun 2012	NUB-L3/1206	0.10	196,758.30	59
Jul 2012	NUB-L3/1207	0.10	248,625.50	75
Aug 2010	NUB-L3/1008	0.10	0.00	0
Total			**479,525.95**	**143**

Total baseline emissions (BE_T) are tabulated in **Table 4** below.

Table 4 Calculation of Total Baseline Emissions

Month	Source of Report	BE_{CH4}	$BE_{LPG\ FEED}$	$BE_{LPG,FUEL}$	BE_T
		tCO_2e	tCO_2e	tCO_2e	tCO_2e
Aug 2010	NUB-L3/1008	1,102	0	0	1,102
Sep 2010	NUB-L3/1009	563	0	0	563
Oct 2010	NUB-L3/1010	1,200	0	0	1,200
Nov 2010	NUB-L3/1011	690	0	0	690
Dec 2010	NUB-L3/1012	1,002	0	0	1,002
Jan 2011	NUB-L3/1101	725	0	0	725
Feb 2011	NUB-L3/1102	597	16	8	621
Mar 2011	NUB-L3/1103	1,460	0	0	1,460
Apr 2011	NUB-L3/1104	430	0	0	430
May 2011	NUB-L3/1105	439	0	0	439
Jun 2011	NUB-L3/1106	989	0	0	989
Jul 2011	NUB-L3/1107	1,207	0	0	1,207
Aug 2011	NUB-L3/1108	722	0	0	722
Sep 2011	NUB-L3/1109	1,306	0	0	1,306
Oct 2011	NUB-L3/1110	1,767	0	0	1,767
Nov 2011	NUB-L3/1111	1,373	0	0	1,373
Dec 2011	NUB-L3/1112	1,607	0	0	1,607
Jan 2012	NUB-L3/1201	1,768	0	0	1,768
Feb 2012	NUB-L3/1202	1,654	0	0	1,654
Mar 2012	NUB-L3/1203	924	0	0	924
Apr 2012	NUB-L3/1204	1,156	3	1	1,160
May 2012	NUB-L3/1205	1,174	0	0	1,174
Jun 2012	NUB-L3/1206	1,589	115	59	1,763
Jul 2012	NUB-L3/1207	1,906	146	75	2,127
Total		**27,350**	**280**	**143**	**27,773**

E.2. Calculation of project emissions or actual net GHG removals by sinks

As per the registered PDD, the project emissions prescribed in AMS-III.H need not be deducted from baseline emissions when the technology implemented does not increase the amount of methane produced per unit of COD removed (refer to Paragraph 34 of AMS-III.H version 9):

- Emission from combustion of fossil fuel to generate power used to run the project equipment (**$PE_{MCS,y,power}$**)
- Methane emission from degradable organic matter in treated wastewater returned to anaerobic lagoon (**$PE_{MCS,y,ww,treated}$**)
- Methane emission from final sludge disposed (**$PE_{MCS,y,s,final}$**)
- Fugitive methane emission from the inefficiency of the AD and flare system (**$PE_{MCS,y,fugitive}$**)
- Methane emission from final treated wastewater disposed to river system (**$PE_{MCS,y,dissolved}$**)

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

To confirm the case, the actual amount of methane production per unit of COD removed from wastewater is calculated during the monitoring period and compared with that for baseline anaerobic lagoons as shown in **Table 5** below.

Table 5 Actual Methane Generation Rate from wastewater in NUBIKA

Wastewater Treated	COD removed	Biogas generated	Methane Content	Methane Generated		CH_4 Generation Rate
m^3	t COD	N m^3	%	N m^3	t CH_4	t CH_4 / t COD
398,785.10	14,392.57	2,218,331	66.32%	1,471,272	1,054.61	0.0733

The actual amount of methane production per unit of COD removed from wastewater based on the actual monitored data is 0.0733 kg CH_4 / kg COD during the monitoring period, which is below the baseline anaerobic lagoons calculated based on the IPCC default values (0.168 kg CH_4 / kg COD). Thus, as per paragraph 34 of AMS-III.H version 9, the project emissions need not be deducted from baseline emissions.

The project emissions prescribed in AMS-III.O are also excluded based on the following reasons:
$PE_y = PE_{y,power} + PE_{y,fuel} + PE_{y,chem}$

- **$PE_{y,power}$** (Project emissions from power used to run biogas purification system); PT Nubika Jaya complex generates its own electricity using biomass power plant and does not use electricity from external sources.
- **$PE_{y,fuel}$** (Project emissions from fuel used to run biogas purification system); The system used low pressure steam to regenerate its carbon bed. For this purpose, the hydrogen production plant is equipped with a waste heat recovery boiler to generate steam using excess heat from the reformer. Thus, the use of fossil fuel for this purpose is unlikely.
- **$PE_{y,chem}$** (Project emissions from the use of additional chemical in the biogas purification system); The system uses steam to regenerate the adsorbent such as carbon. No chemical will be used for the operation.

While the complex self-generates its own electricity using biomass power plant, there are three diesel generators (2 x 500kW and 1 x 300kW) which act as the stand-by in case of emergency shutdown. As shown in **Table 6** below, project emission due to diesel oil consumption by the project activity during the monitoring period was approximately 86 tCO_2e. This is less than 1% of the baseline emissions of 27,773 tCO_2e, and deemed to be negligible.

Table 6 Diesel Oil consumption by Nubika captive power plant

Month	Diesel Oil Consumption[1])	Diesel Oil Density[2)]	Diesel Oil NCV[3)]	Diesel Oil Emission Factor[4)]	CO_2 emissions
	Litres (L)	Kg/L	TJ/Gg	tCO_2/TJ	tCO_2e
2010/08 – 2010/12	6,271.20	0.89	43.3	74.8	18.08
2011/01 – 2011/12	12,448.29				35.88
2012/01 – 2012/07	11,096.94				31.99
TOTAL	**29,816.43**				**85.95 ≒86**

1) Consumption by biogas and hydrogen plants (15% of total diesel oil consumption)
2) Maximum value (value from PERTAMINA – National Oil and Gas Company is 0.87)
3) IPCC 2006 Vol. 2 Table 1.2; upper limit of NCV
4) IPCC 2006 Vol. 2 Table 1.4; upper value

Thus, it is concluded that there is no project emission from this project activity for the monitoring period 01/08/2010 – 31/07/2012.

PE_T = 0 tCO_2 e

E.3. Calculation of leakage

The adopted methodology AMS-III.H and AMS-III.O stipulate that leakage effect is to be considered if the project technology is equipment transferred from another activity or if the existing equipment is transferred to another activity. In the case of the project, the project equipment is new and the anaerobic lagoons are not used by activities other than the project activity and thus such leakage is not relevant.

With consideration of the requirement contained in paragraph 23b of AMS-III.O, the leakage emissions from physical loss of biogas is calculated by maintaining methane balance between the source of methane generation (anaerobic digester) and the consumers of biogas (flare and hydrogen production unit) as per the following equation:

$$L_{y,CH4} = X_{CH4,y} \times \frac{P_N * [V_{AD} - V_{TR,y}]}{R * T_N} \times \frac{MW_{CH4}}{X_1} \times GWP_{CH4}$$

Parameter	Description	Unit
$L_{y,CH4}$	Methane loss from physical installations	tCO_2/yr
$X_{CH4,y}$	Proportion of methane in biogas in volume/volume basis	Nm^3/Nm^3
P_N	Reference pressure at normal condition in Pascal	Pa
V_{AD}	Volumetric amount of biogas recovered at source (at outlet of Anerobic Digester) prior to distribution to users.	Nm^3/yr
$V_{TR,y}$	Volumetric amount of biogas recovered	Nm^3/yr
R	Ideal gas constant	m^3.Pa/mol.K
T_N	Reference temperature at normal condition in Kelvin	K
MW_{CH4}	Molecular weight of methane	gram/mol
X_1	Conversion factor 10^6 grams/tones	gram/ton
GWP_{CH4}	Global warming potential of methane	tCO_2/tCH_4

The result is tabulated in the following **Table 7**.

Table 7 Calculation of Methane loss from physical leakage of biogas

Month	Source of Report	V_{AD}[2]	V_{TR}	X_{CH4}	L_{CH4}
		N m^3	N m^3	%	tCO_2 e
Aug 2010	NUB-L3/1008	48,243.83	104,656.1	71.21%	0
Sep 2010	NUB-L3/1009	29,753.57	55,164.0	69.06%	0
Oct 2010	NUB-L3/1010	129,262.64	117,228.6	69.20%	124
Nov 2010	NUB-L3/1011	75,045.26	66,591.7	70.05%	88

[2] V_{AD} (Volumetric amount of biogas recovered at source (at outlet of Anerobic Digester) prior to distribution to users) was conservatively adjusted by accounting maximum uncertainty of 4%.

Dec 2010	NUB-L3/1012	102,302.62	98,046.0	69.13%	44
Jan 2011	NUB-L3/1101	71,587.46	73,293.9	66.90%	0
Feb 2011	NUB-L3/1102	27,347.74	62,969.4	64.13%	0
Mar 2011	NUB-L3/1103	17,874.27	139,475.4	70.76%	0
Apr 2011	NUB-L3/1104	11,189.88	40,958.1	71.03%	0
May 2011	NUB-L3/1105	8,539.54	42,093.1	70.50%	0
Jun 2011	NUB-L3/1106	48,728.16	102,918.2	64.98%	0
Jul 2011	NUB-L3/1107	100,583.50	136,020.4	59.98%	0
Aug 2011	NUB-L3/1108	67,453.46	80,241.5	60.87%	0
Sep 2011	NUB-L3/1109	110,305.62	141,180.6	62.56%	0
Oct 2011	NUB-L3/1110	165,873.55	198,281.4	60.26%	0
Nov 2011	NUB-L3/1111	172,961.67	154,856.0	59.94%	161
Dec 2011	NUB-L3/1112	179,562.34	180,072.7	60.35%	0
Jan 2012	NUB-L3/1201	182,573.46	187,259.7	63.82%	0
Feb 2012	NUB-L3/1202	165,061.83	166,006.3	67.38%	0
Mar 2012	NUB-L3/1203	57,196.36	89,636.6	69.73%	0
Apr 2012	NUB-L3/1204	85,692.57	113,263.0	68.98%	0
May 2012	NUB-L3/1205	77,051.73	113,337.9	70.07%	0
Jun 2012	NUB-L3/1206	116,644.32	157,819.1	68.07%	0
Jul 2012	NUB-L3/1207	167,495.22	205,237.3	62.80%	0
Total / *Average*		**2,218,330.61**	**2,826,606.98**	*66.32%*	**417**

E.4. Summary of calculation of emission reductions or net anthropogenic GHG removals by sinks

Time Period	Baseline emissions or baseline net GHG removals by sinks (tCO_2e)	Project emissions or actual net GHG removals by sinks (tCO_{2e})	Leakage (tCO_2e)	Emission reductions or net anthropogenic GHG removals by sinks (tCO_2e)
Total	27,773	0	417	27,356

E.5. Comparison of actual emission reductions or net anthropogenic GHG removals by sinks with estimates in registered PDD

Item	Values estimated in ex-ante calculation of registered PDD	Actual values achieved during this monitoring period
Emission reductions or GHG removals by sinks (tCO_2e)	88,362	27,356

The table above shows the comparison of actual values of the emission reductions achieved during the monitoring period with the estimations in the registered CDM-PDD. The estimated annual emission reduction for this project as in its registered PDD is 44,181 tCO_2e. Thus, for the monitoring period of 2 years, the estimated emission reduction is 88,136 tCO_2e.

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

The emission reduction within the period of 01/08/2010 – 31/07/2012 (2 years) is calculated to be **27,356 tCO_2e** (about 30.96% of the estimated in ex-ante calculation). This value is below the expectation in the PDD, which is 88,362 tCO_2e for 2 years.

The shortage is primarily due to the following reasons:

- The biogas plant was not able to be operating fully as per the initial specification. Thus, the methane recovered by the plant is not as high as the expectation when it operates in its maximum specification. The methane generation rate calculated during the monitoring period is only 0.0733 kg CH_4 / kg COD, as compared to the baseline AD of 0.168 kg CH_4 / kg COD (about 43.63%). The project participant has continuously worked to improve the biogas plant's efficiency and has also invited the technology provider to resolve the issue. The progress for improvement of plant's efficiency is expected to be a long term effort requiring both Nubika biogas engineers and technology provider's cooperation.

- The operation of using LPG as feedstock in the hydro-chem plant was just started in April 2012 due to difficulties to fulfill the requirement for quality of biogas to be used as feedstock for hydrogen production. Thus, emission reductions attributed to the displacement of LPG in hydrogen production unit is only achieved from April 2012 onwards.

- The production process in the plant was not running in full operation due to troubles occurred during the project operations and shutdowns in the operation due to maintenance in oleochemical plant and long holidays.

In conclusion, the management of PT Nubika Jaya believes that it has implemented the project in accordance with its Project Design Document version 4.1.0 (UNFCCC Reference ID: 2421). NUBIKA also believes that its CDM team has taken all necessary actions to maintain credibility and transparency of data through proper supervision and administration. Thus, the project developer requests the verification process of the resulting emission reductions to be advanced.

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History of the document

Version	Date	Nature of revision
02.0	EB 66 13 March 2012	Revision required to ensure consistency with the "Guidelines for completing the monitoring report form" (EB 66, Annex 20).
01	EB 54, Annex 34 28 May 2010	Initial adoption.
Decision Class: Regulatory **Document Type**: Form **Business Function**: Issuance		