Monitoring report form (Version 03.1)

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	3.0
Completion date of the monitoring report	26/08/2013
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	**27,012 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.

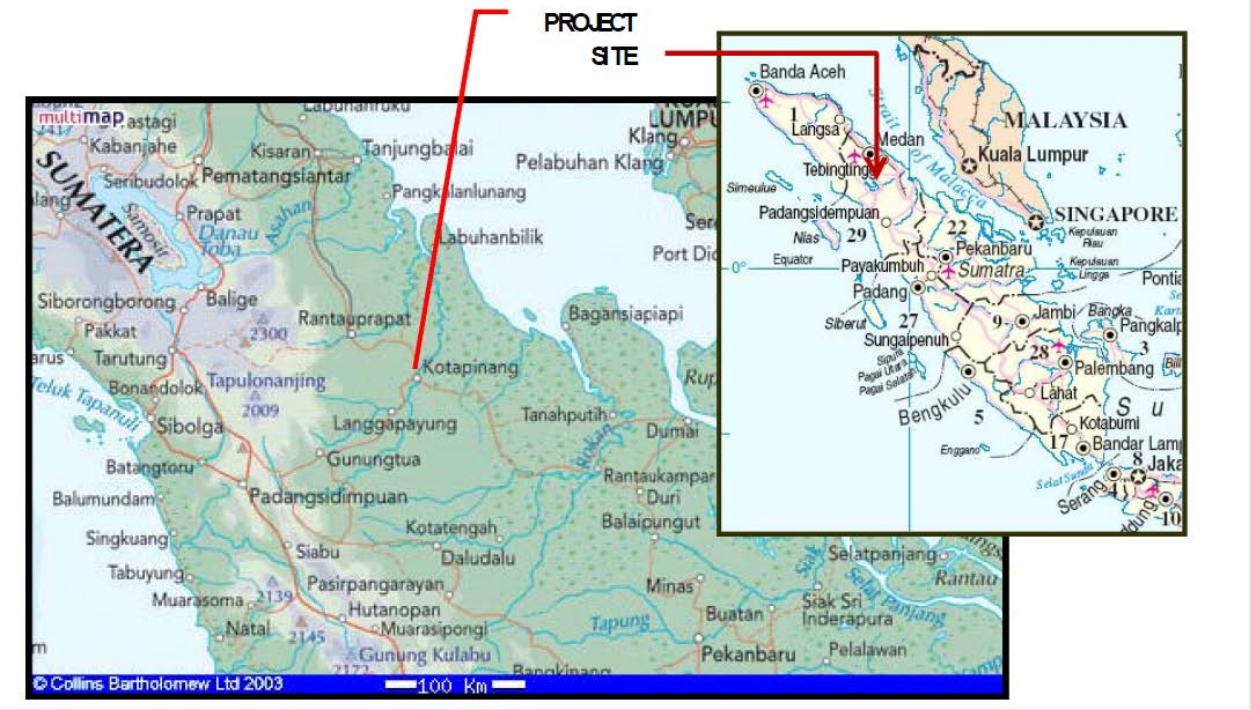
The project has been approved by Indonesia DNA, National Committee on CDM (NC-CDM) on 25/09/2008 and officially registered with CDM Executive Board on 30/06/2009 with registration number 2421. The construction of Methane Capture System (MCS) and biogas treatment facility to support hydrogen production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

The total Emission Reduction claimed for the 2nd Monitoring Period from 01/08/2010 to 31/07/2012 is **27,012 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 first 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 monitoring system was provided by Endress+Hauser and commissioned in 04/2010.

During the 2nd monitoring period, NUBIKA has continuously strived to reduce both H_2S and moisture content 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 plant to produce hydrogen from biogas, and therefore there is no reference plant currently available. Eventually, NUBIKA succeeded in feeding biogas as the feedstock for hydrogen production in April 2012 and the plant has been fully operated since June 2012.

To reduce the risk of data loss during off-site calibration, NUBIKA has also prepared additional back-up flowmeters (F-00 to F-06), such that the data loss due to the inavailability of monitoring equipments may be minimized. When the monitoring equipments are due for calibration, they are then replaced by their backup flowmeters while waiting for the calibration sent to accredited calibration entity.

During the 2nd monitoring period, flowmeters F-00 to F-06 have ever been replaced by their back-up units to avoid data loss during off-site calibration as follows :
F-00 (Serial No. 9900532000) was replaced with the backup unit (Serial No. EA166719000) on 03/11/2011.
F-01 (Serial No. CC031202000) was replaced with the backup unit (Serial No. E7048E02000) on 14/07/2011.
F-02 (Serial No. A901BF02000) was replaced with the backup unit (Serial No. E102F702000) on 07/01/2011) and then replaced back to the main unit (A901BF02000) on 14/10/2011.
F-03 (Serial No. 99005122000) was replaced with the backup unit (Serial No. E102F802000) on 07/01/2011) and then replaced back to the main unit (99005122000) on 14/10/2011.
F-04 (Serial No. N1-X622-9087676) was replaced with the backup unit (Serial No. N1-B314-9024712) on 04/04/2011.
F-05 (Serial No. 1X-V009-9037948) was replaced with the backup unit (Serial No. 1X-V009-9037944) on 07/11/2011.
F-06 (Serial No. 1X-V009-9037945) was replaced with the backup unit (Serial No. N1-BN08-9078867) on 15/11/2011.

For the CDM training plan, NUBIKA has scheduled an annual training and information meeting to keep the personnels responsible for monitoring and reporting of the data up-to-date on the recent changes happening towards the project. The contents and discussions during the training are then recorded and documented in the meeting minutes / report. During the 2nd monitoring period, the training was conducted on 23/08/2011 and 30/07/2012.

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 biogas plant's efficiency to produce more biogas, which in turn will result in improved accuracy of monitoring of biogas recovered from Anaerobic Digester (AD). NUBIKA has invited the technology provider of AD (Aquarius Systems Malaysia) in early 2012 to study the cause of the low efficiency, and the performance of AD has been improved towards the specification level in the last few months of this monitoring period. In terms of accuracy of flow meter, NUBIKA has also replaced the flow meter F-01 with the backup unit to improve the accuracy. Eventually, the flow meter F-01 to F-03 were further replaced with the new meters with smaller diameter on 04/06/2013 to account for actual biogas flow during 2nd monitoring period as follows :

F-01 was replaced with diameter 3 inch flowmeter DN80 (Serial No. FC0BA902000)
F-02 was replaced with diameter 2 inch flowmeter DN50 (Serial No. FC0A0102000)
F-03 was replaced with diameter 3 inch flowmeter DN80 (Serial No. FC0BAA02000)

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

The Post-registration changes for the Corrections, Permanent changes from the registered monitoring plan or monitoring methodology and Changes to the project design of a registered project activity were submitted during the first monitoring period and approved by the CDM-EB on 19/07/2011. However, there are no Post-registration changes for this monitoring period as mentioned below.

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

Not Applicable

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

Not Applicable

B.2.5. Changes to start date of crediting period

Not Applicable

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

Not applicable

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** :

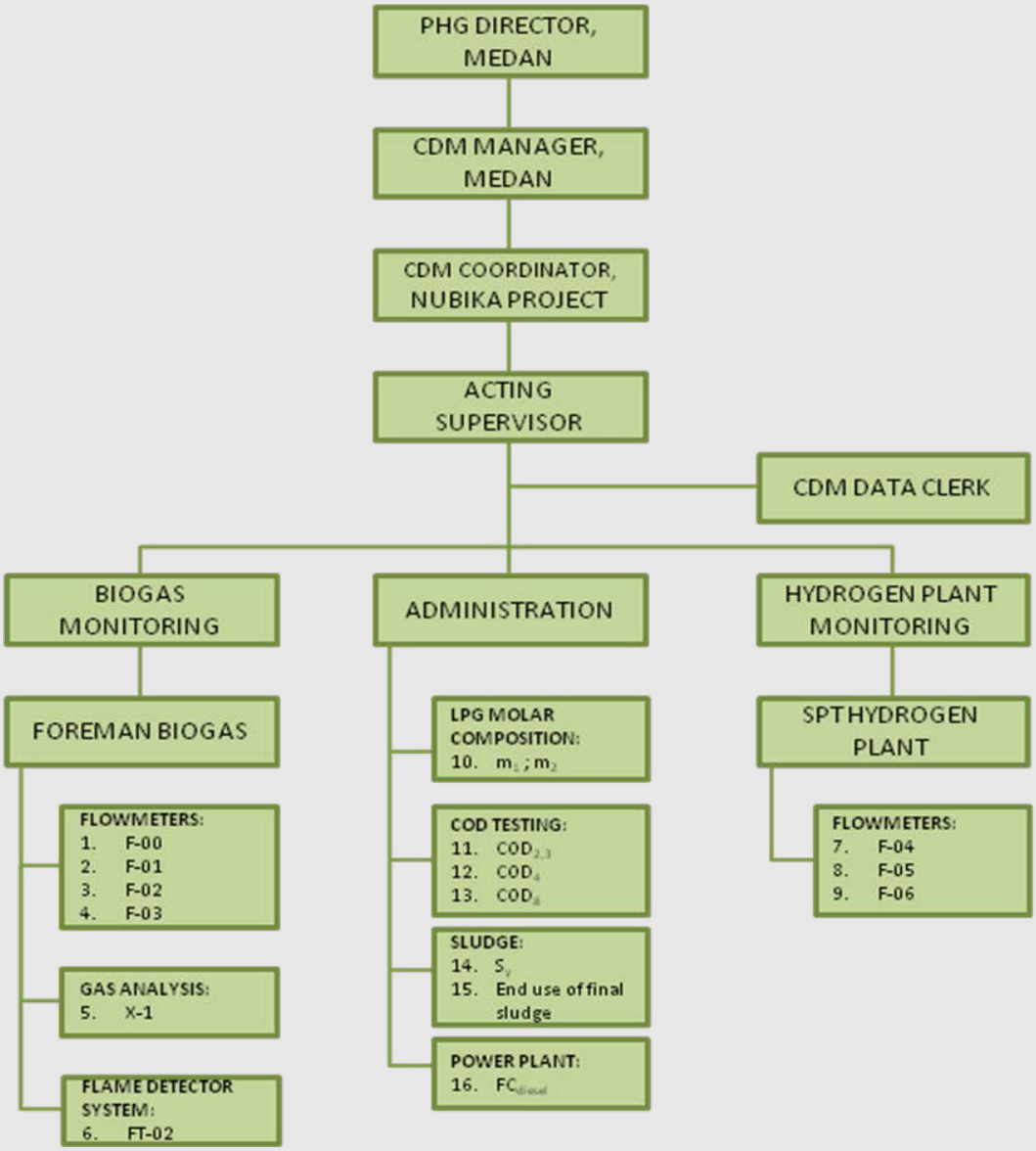


Figure 1 Organizational Structure of NUBIKA CDM monitoring team

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

Figure 2 illustrates the roles of CDM team's staffs and information flow in the monitoring activity during the monitoring period :

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 in Section D.2 according to the approved revised monitoring plan.

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 Monitoring Report on emission reductions which have been achieved in this monitoring period and will be approved by PHG Board of Director.

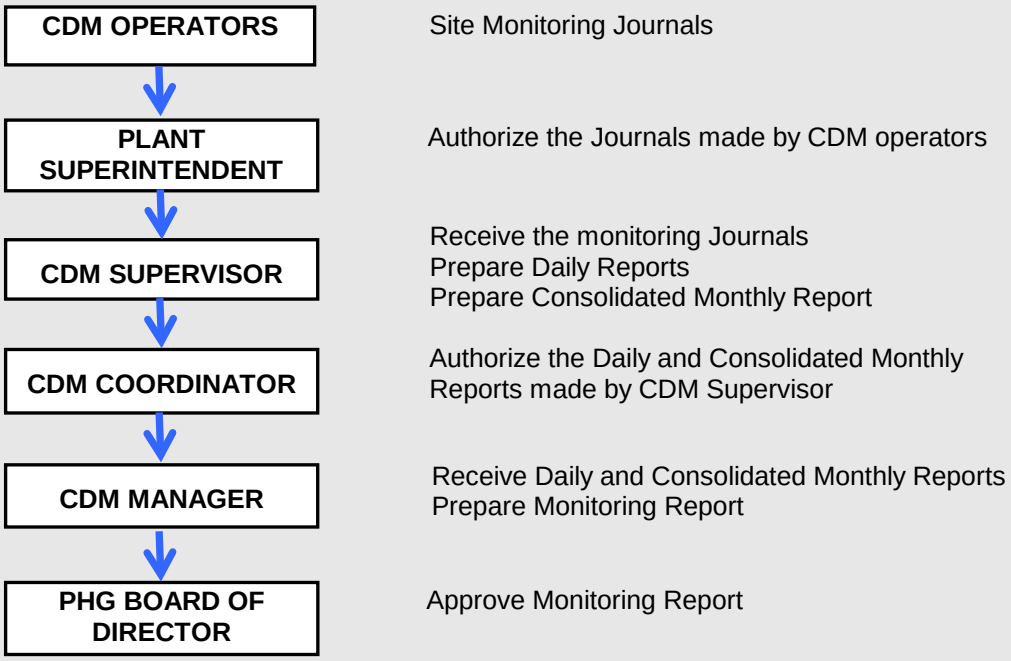


Figure 2 Reporting Structure for each CDM monitoring team

Data Archiving

To maintain archives of data and to prevent loss 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.

CDM Staffs Training plan

A one-day training and information session is scheduled every year to keep the Nubika personnels responsible for monitoring and reporting of the data up-to-date on the recent changes happening towards the

project. This session will be conducted with the lead and presentation by CDM Manager. The Consultant of the CDM project may also join to update the status of the project and changes towards the monitoring and reporting based on Standard Operating Procedure.

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**:

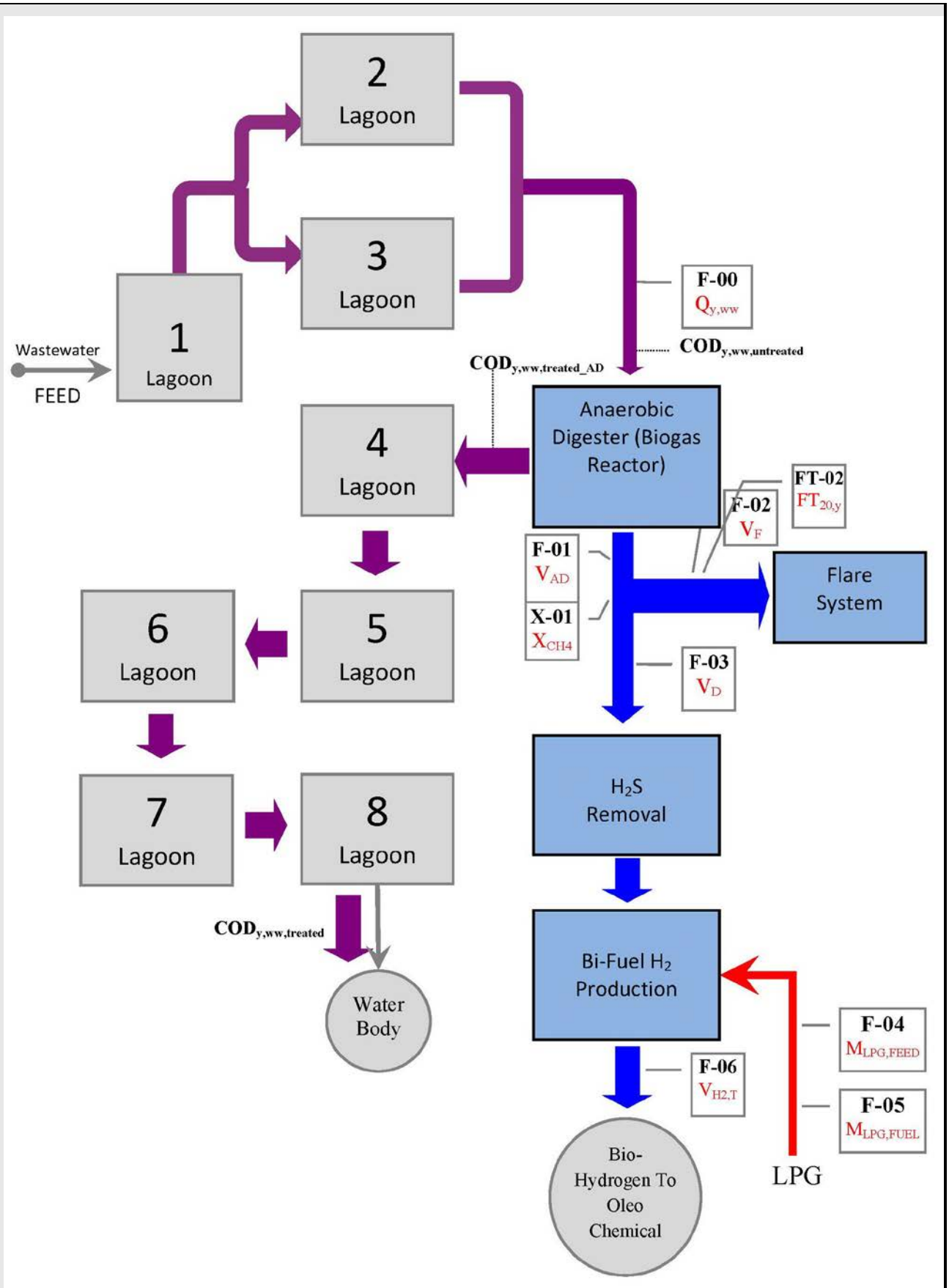


Figure 3. Diagram of Monitoring Points for the Project

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 and leakage 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 and leakage 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 and leakage 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 and leakage 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 paragraph 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 and leakage 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:	See table below
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
Purpose of data:	Baseline emission calculations
Additional comment:	N/A

Year	**Quarter**	**m_1**	**m_2**
2010	**3**	**49.08**	**50.63**
2010	**4**	**53.14**	**46.64**
2011	**1**	**42.83**	**56.77**
2011	**2**	**44.15**	**55.32**
2011	**3**	**43.18**	**56.96**
2011	**4**	**43.53**	**55.92**
2012	**1**	**42.13**	**56.58**
2012	**2**	**38.88**	**60.82**
2012	**3**	**No LPG purchase in this period**	

Year	Quarter	Report No.	Test Date
2010	3	0111/L/LPG/2010	16/08/2010
2010	4	0141/L/LPG/2010	31/10/2010
2011	1	0012/L/LPG/2011	26/01/2011
2011	2	0063/L/LPG/2011	04/05/2011
2011	3	0107/L/LPG/2011	25/07/2011
2011	4	0192/L/LPG/2011	20/10/2011
2012	1	0036/L/LPG/2012	25/01/2012
2012	2	0156/L/LPG/2012	26/05/2012
2012	3	No LPG purchase in this period	

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:	<table><tr><th>Year</th><th>Quarter</th><th>EF_{LPG}</th></tr><tr><td>2010</td><td>3</td><td>3.0199</td></tr><tr><td>2010</td><td>4</td><td>3.0185</td></tr><tr><td>2011</td><td>1</td><td>3.0219</td></tr><tr><td>2011</td><td>2</td><td>3.0215</td></tr><tr><td>2011</td><td>3</td><td>3.0219</td></tr><tr><td>2011</td><td>4</td><td>3.0217</td></tr><tr><td>2012</td><td>1</td><td>3.0220</td></tr><tr><td>2012</td><td>2</td><td>3.0232</td></tr><tr><td>2012</td><td>3</td><td>No LPG purchase in this period</td></tr></table>
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:	**1,619,404**
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 (manufacturer's recommendation) Date of calibration: 28/04/2010 Validity: 28/04/2010 – 27/04/2011 Date of last calibration: 07/02/2013 Validity: 07/02/2013 – 06/02/2014 Serial Number: N1-B314-9024712 (Replacement) Calibration frequency: Every year (manufacturer's recommendation) Date of last calibration: 04/04/2011 Validity: 04/04/2011 – 03/04/2012 Note : Due to calibration delay, $M_{LPG\ FEED}$ data from 04/04/2012 – 31/07/2012 was increased by maximum error of 4% as per Guidelines for assessing compliance with the calibration frequency requirements (EB52 Annex 60)

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% as per the approved revised PDD
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 (manufacturer's recommendation) Date of last calibration: 28/04/2010 Validity: 28/04/2010 – 27/04/2011 Serial Number: 1X-V009-9037944 (Replacement) Calibration frequency: Every year (manufacturer's recommendation) Date of last calibration: 07/11/2011 Validity: 07/11/2011 – 06/11/2012 Note : Due to calibration delay, $M_{LPG\ FUEL}$ data from 28/04/2011 – 06/11/2011 was decreased by maximum error of 4% as per Guidelines for assessing compliance with the calibration frequency requirements (EB52 Annex 60)
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% as per the approved revised PDD
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:	**66.29** Average value throughout the 2nd monitoring period
Monitoring equipment:	Type: AwiFlex Series 7 Accuracy: ±2% (Manufacturer's specification) Serial Number: 670_09 Calibration frequency: Every year Date of calibration: 22/01/2010 Validity: 22/01/2010 – 21/01/2011 Date of calibration: 21/01/2011 Validity: 21/01/2011 – 20/01/2012 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% as per the approved revised PDD
Purpose of data:	Baseline and leakage 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 (Check and Test) Date of check: 23/12/2009 Validity: 23/12/2009 – 22/12/2010 Date of check: 22/12/2010 Validity: 22/12/2010 – 21/12/2011 Date of last check: 19/12/2011 Validity: 19/12/2011 – 18/12/2012
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:	**2,218,331**
Monitoring equipment:	Type: E+H PROWIRL 72F1F-SE0BA12AA4AW Accuracy: <1% (ISO/DIN 11631) Serial Number: CC031202000 Calibration frequency: Every 2 years Date of last calibration: 10/12/2009 Validity: 10/12/2009 – 09/12/2011 Serial Number: E7048E02000 (Replacement) Calibration frequency: Every 2 years Date of last calibration: 14/07/2011 Validity: 14/07/2011 – 13/07/2013
Measuring/Reading/Recording frequency:	Continuous measurement; Logged manually on hourly basis and aggregated daily
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 the approved revised 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:	**1,743,451**
Monitoring equipment:	Type: E+H PROWIRL 72F1H-SE0AA1AAA4AA Accuracy: <1% (ISO/DIN 11631) Serial Number: 99005120000 Calibration frequency: Every year (Calibration certificate) Date of calibration: 09/04/2010 Validity: 09/04/2010 – 08/04/2011 Date of last calibration: 14/10/2011 Validity: 14/10/2011 – 13/10/2012 Serial Number: E102F802000 (Replacement) Calibration frequency: Every 2 years Date of last calibration: 07/01/2011 Validity: 07/01/2011 – 06/01/2013
Measuring/Reading/Recording frequency:	Continuous measurement; Logged manually on hourly basis and aggregated daily
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 the approved revised 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:	**1,083,156**

Monitoring equipment:	Type: E+H PROWIRL 72F1H-SE0AA1AAA4AA Accuracy: <1% (ISO/DIN 11631) Serial Number: A901BF02000 Calibration frequency: Every year (Calibration certificate) Date of calibration: 09/04/2010 Validity: 09/04/2010 – 08/04/2011 Date of last calibration: 14/10/2011 Validity: 14/10/2011 – 13/10/2012 Serial Number: E102F702000 (Replacement) Calibration frequency: Every 2 years Date of last calibration: 07/01/2011 Validity: 07/01/2011 – 06/01/2013
Measuring/Reading/Recording frequency:	Continuous measurement; Logged manually on hourly basis
Calculation method (if applicable):	N/A
QA/QC procedures:	Instrument is calibrated by an ISO/IEC17025 accredited third party. Uncertainty: Error level of maximum 4% (as per the approved revised 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:	**4,962,308**
Monitoring equipment:	Type: Flow meter Siemens SITRANS 7MF4433-1EA22-1NC7-Z Accuracy: <0.55% (EN60770-1) Serial Number: 1X-V009-9037945 Calibration frequency: Every year (Manufacturer's recommendation) Date of last calibration: 01/06/2010 Validity: 01/06/2010 – 31/05/2011 Serial Number: N1-BN08-9078867 (Replacement) Calibration frequency: Every year (Manufacturer's recommendation) Date of last calibration: 15/11/2011 Validity: 15/11/2011 – 14/11/2012 Note : Due to calibration delay, $V_{H2,T}$ data from 01/06/2011 – 14/11/2011 was decreased by maximum error of 4% as per Guidelines for assessing compliance with the calibration frequency requirements (EB52 Annex 60)

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 the approved revised 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**
Monitoring equipment:	Type: E+H PROMAG 10W80–SCOA1AAOA4AA Accuracy: 0.5 % (DIN29104) Serial Number: 99005320000 Calibration frequency: Every 2 years Date of last calibration: 13/04/2010 Validity: 13/04/2010 – 12/04/2012 Serial Number: EA166719000 (Replacement) 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)
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:	**0.0481**
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 Note : Due to calibration delay, $COD_{y,ww,untreated}$ data from 29/05/2011 – 18/12/2011 was adjusted by accuracy of 0.5% as per Guidelines for assessing compliance with the calibration frequency requirements (EB52 Annex 60)
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 Note : Due to calibration delay, $COD_{y,ww,treated\_AD}$ data from 29/05/2011 – 18/12/2011 was adjusted by accuracy of 0.5% as per Guidelines for assessing compliance with the calibration frequency requirements (EB52 Annex 60)
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 Note : Due to calibration delay, $COD_{y,ww,treated}$ data from 29/05/2011 – 18/12/2011 was adjusted by accuracy of 0.5% as per Guidelines for assessing compliance with the calibration frequency requirements (EB52 Annex 60)

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:	**0.0479**
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:	**0.0364**
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 calculated every month $COD_{y,removed,AD} = COD_{y,ww,untreated} - COD_{y,ww,treated\_AD}$
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**
Monitoring equipment:	Type: GASBOY Series 4860-9S Accuracy: ±0.5% (Manufacturer's specification) Serial Number: 00560 Calibration frequency: Every 2 years (Calibration certificate) Date of calibration: 20/12/2009 Validity: 20/12/2009 – 19/12/2011 Date of last calibration: 11/12/2011 Validity: 11/12/2009 – 10/12/2013
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 approved revised 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 summarized in **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	63,892	40,764	104,656	71.06%	1,100
Sep 2010	NUB-L3/1009	34,355	20,809	55,164	68.94%	562
Oct 2010	NUB-L3/1010	104,704	12,525	117,229	68.84%	1,193
Nov 2010	NUB-L3/1011	54,400	12,192	66,592	69.88%	688

Dec 2010	NUB-L3/1012	95,324	2,722	98,046	69.22%	1,004
Jan 2011	NUB-L3/1101	64,364	8,930	73,294	66.55%	721
Feb 2011	NUB-L3/1102	46,579	16,390	62,969	71.71%	668
Mar 2011	NUB-L3/1103	117,394	22,082	139,475	70.79%	1,460
Apr 2011	NUB-L3/1104	20,200	20,759	40,958	70.29%	425
May 2011	NUB-L3/1105	6,289	35,805	42,093	67.76%	421
Jun 2011	NUB-L3/1106	98,873	4,045	102,918	64.74%	985
Jul 2011	NUB-L3/1107	88,338	47,683	136,020	59.94%	1,206
Aug 2011	NUB-L3/1108	49,953	30,288	80,242	60.23%	715
Sep 2011	NUB-L3/1109	51,226	89,955	141,181	61.91%	1,293
Oct 2011	NUB-L3/1110	83,667	114,614	198,281	60.21%	1,766
Nov 2011	NUB-L3/1111	44,311	110,545	154,856	60.05%	1,375
Dec 2011	NUB-L3/1112	53,099	126,973	180,073	59.87%	1,595
Jan 2012	NUB-L3/1201	69,647	117,613	187,260	63.05%	1,746
Feb 2012	NUB-L3/1202	77,732	88,274	166,006	67.25%	1,651
Mar 2012	NUB-L3/1203	28,819	60,818	89,637	69.46%	921
Apr 2012	NUB-L3/1204	85,714	27,549	113,263	68.90%	1,154
May 2012	NUB-L3/1205	107,339	5,999	113,338	69.92%	1,172
Jun 2012	NUB-L3/1206	150,995	6,824	157,819	67.67%	1,579
Jul 2012	NUB-L3/1207	146,240	58,997	205,237	62.65%	1,902
	Total / *Average*	**1,743,451**	**1,083,156**	**2,826,607**	*66.29%*	**27,302**

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 summarized in **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	49.08%	50.63%	112,917	47,493	4,972	10,708	0	0

Sep 2010	NUB-L3/1009	49.08%	50.63%	95,779	45,755	4,218	10,316	0	0
Oct 2010	NUB-L3/1010	53.14%	46.64%	294,485	103,088	12,967	23,256	0	0
Nov 2010	NUB-L3/1011	53.14%	46.64%	134,527	69,819	5,924	15,751	0	0
Dec 2010	NUB-L3/1012	53.14%	46.64%	362,189	108,733	15,949	24,529	0	0
Jan 2011	NUB-L3/1101	42.83%	56.77%	295,272	87,136	13,002	19,630	0	0
Feb 2011	NUB-L3/1102	42.83%	56.77%	196,946	37,373	8,672	8,419	253	3
Mar 2011	NUB-L3/1103	42.83%	56.77%	365,178	120,019	16,080	27,038	0	0
Apr 2011	NUB-L3/1104	44.15%	55.32%	12,922	3,507	569	790	0	0
May 2011	NUB-L3/1105	44.15%	55.32%	8,411	6,736	370	1,518	0	0
Jun 2011	NUB-L3/1106	44.15%	55.32%	249,421	103,867	10,983	23,403	0	0
Jul 2011	NUB-L3/1107	43.18%	56.96%	289,933	119,625	12,767	26,949	0	0
Aug 2011	NUB-L3/1108	43.18%	56.96%	165,383	64,378	7,282	14,503	0	0
Sep 2011	NUB-L3/1109	43.18%	56.96%	93,686	41,019	4,125	9,241	0	0
Oct 2011	NUB-L3/1110	43.53%	55.92%	223,371	89,010	9,836	20,054	0	0
Nov 2011	NUB-L3/1111	43.53%	55.92%	244,534	98,252	10,768	22,136	0	0
Dec 2011	NUB-L3/1112	43.53%	55.92%	268,656	103,227	11,830	23,257	0	0
Jan 2012	NUB-L3/1201	42.13%	56.58%	251,012	108,877	11,053	24,527	0	0
Feb 2012	NUB-L3/1202	42.13%	56.58%	329,928	100,758	14,528	22,698	0	0
Mar 2012	NUB-L3/1203	42.13%	56.58%	122,760	44,636	5,406	10,055	0	0
Apr 2012	NUB-L3/1204	38.88%	60.82%	201,871	45,586	8,889	10,264	0	0
May 2012	NUB-L3/1205	38.88%	60.82%	197,742	70,509	8,707	15,876	0	0
Jun 2012	NUB-L3/1206	38.88%	60.82%	196,758	0	8,664	0	8,664	116
Jul 2012	NUB-L3/1207	38.88%	60.82%	248,626	0	10,948	0	10,948	146
Total				**4,962,308**	**1,619,404**	**218,511**	**364,919**	**19,865**	**265**

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 summarized in **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	0
Sep 2010	NUB-L3/1009	0.10	0	0
Oct 2010	NUB-L3/1010	0.10	0	0
Nov 2010	NUB-L3/1011	0.10	0	0
Dec 2010	NUB-L3/1012	0.10	0	0
Jan 2011	NUB-L3/1101	0.10	0	0
Feb 2011	NUB-L3/1102	0.10	5,745	1
Mar 2011	NUB-L3/1103	0.10	0	0
Apr 2011	NUB-L3/1104	0.10	0	0
May 2011	NUB-L3/1105	0.10	0	0
Jun 2011	NUB-L3/1106	0.10	0	0
Jul 2011	NUB-L3/1107	0.10	0	0
Aug 2011	NUB-L3/1108	0.10	0	0
Sep 2011	NUB-L3/1109	0.10	0	0
Oct 2011	NUB-L3/1110	0.10	0	0
Nov 2011	NUB-L3/1111	0.10	0	0
Dec 2011	NUB-L3/1112	0.10	0	0
Jan 2012	NUB-L3/1201	0.10	0	0
Feb 2012	NUB-L3/1202	0.10	0	0
Mar 2012	NUB-L3/1203	0.10	0	0
Apr 2012	NUB-L3/1204	0.10	0	0
May 2012	NUB-L3/1205	0.10	0	0
Jun 2012	NUB-L3/1206	0.10	0	0
Jul 2012	NUB-L3/1207	0.10	196,758	59
Aug 2010	NUB-L3/1008	0.10	248,626	75
Total			**451,128**	**135**

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

Table 4 Calculation of Total Baseline Emissions

Month	Source of Report	BE_{CH4}	$BE_{LPG\ FEED}$	$BE_{LPG,FUEL}$	BE_T
		$tCO_2\ e$	$tCO_2\ e$	$tCO_2\ e$	$tCO_2\ e$
Aug 2010	NUB-L3/1008	1,100	0	0	1,100
Sep 2010	NUB-L3/1009	562	0	0	562
Oct 2010	NUB-L3/1010	1,193	0	0	1,193
Nov 2010	NUB-L3/1011	688	0	0	688
Dec 2010	NUB-L3/1012	1,004	0	0	1,004
Jan 2011	NUB-L3/1101	721	0	0	721
Feb 2011	NUB-L3/1102	668	3	1	672
Mar 2011	NUB-L3/1103	1,460	0	0	1,460
Apr 2011	NUB-L3/1104	425	0	0	425
May 2011	NUB-L3/1105	421	0	0	421
Jun 2011	NUB-L3/1106	985	0	0	985
Jul 2011	NUB-L3/1107	1,206	0	0	1,206
Aug 2011	NUB-L3/1108	715	0	0	715
Sep 2011	NUB-L3/1109	1,293	0	0	1,293
Oct 2011	NUB-L3/1110	1,766	0	0	1,766
Nov 2011	NUB-L3/1111	1,375	0	0	1,375
Dec 2011	NUB-L3/1112	1,595	0	0	1,595
Jan 2012	NUB-L3/1201	1,746	0	0	1,746
Feb 2012	NUB-L3/1202	1,651	0	0	1,651

Mar 2012	NUB-L3/1203	921	0	0	921
Apr 2012	NUB-L3/1204	1,154	0	0	1,154
May 2012	NUB-L3/1205	1,172	0	0	1,172
Jun 2012	NUB-L3/1206	1,579	116	59	1,754
Jul 2012	NUB-L3/1207	1,902	146	75	2,123
Total		**27,302**	**265**	**135**	**27,702**

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**.

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	**14,353**	**2,826,607**	**66.29%**	**1,873,666**	**1,343.04**	**0.0936**

The actual amount of methane production per unit of COD removed from wastewater based on the actual monitored data is 0.0936 kg CH_4 / kg COD during the monitoring period, which is below the value of baseline anaerobic lagoons (0.168 kg CH_4 / kg COD) calculated based on the IPCC default values (0.21 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 uses low pressure steam to regenerate its carbon bed in the PSA. 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**, project emissions 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 27,702 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	0.89	43.3	74.8	18.08
2011/01 – 2011/12	12,448				35.88
2012/01 – 2012/07	11,097				31.99
TOTAL	**29,816**				**85.95 ~86**

1) Consumption by biogas and hydrogen plants (15% of total diesel oil consumption at Nubika Jaya)
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 during the monitoring period of 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 summarized in **Table 7**.

Table 7 Calculation of Methane loss from physical leakage of biogas

Month	Source of Report	V_{AD}[1]	V_{TR}	X_{CH4}	L_{CH4}
		N m^3	N m^3	%	tCO_2 e
Aug 2010	NUB-L3/1008	48,244	104,656	71.06%	0
Sep 2010	NUB-L3/1009	29,754	55,164	68.94%	0
Oct 2010	NUB-L3/1010	129,263	117,229	68.84%	123
Nov 2010	NUB-L3/1011	75,045	66,592	69.88%	88
Dec 2010	NUB-L3/1012	102,303	98,046	69.22%	44
Jan 2011	NUB-L3/1101	71,587	73,294	66.55%	0
Feb 2011	NUB-L3/1102	27,348	62,969	71.71%	0
Mar 2011	NUB-L3/1103	17,874	139,475	70.79%	0
Apr 2011	NUB-L3/1104	11,190	40,958	70.29%	0
May 2011	NUB-L3/1105	8,540	42,093	67.76%	0
Jun 2011	NUB-L3/1106	48,728	102,918	64.74%	0
Jul 2011	NUB-L3/1107	100,583	136,020	59.94%	0
Aug 2011	NUB-L3/1108	67,453	80,242	60.23%	0
Sep 2011	NUB-L3/1109	110,306	141,181	61.91%	0
Oct 2011	NUB-L3/1110	165,874	198,281	60.21%	0
Nov 2011	NUB-L3/1111	172,962	154,856	60.05%	161
Dec 2011	NUB-L3/1112	179,562	180,073	59.87%	0
Jan 2012	NUB-L3/1201	182,573	187,260	63.05%	0
Feb 2012	NUB-L3/1202	165,062	166,006	67.25%	0
Mar 2012	NUB-L3/1203	57,196	89,637	69.46%	0
Apr 2012	NUB-L3/1204	85,693	113,263	68.90%	0
May 2012	NUB-L3/1205	77,052	113,338	69.92%	0
Jun 2012	NUB-L3/1206	116,644	157,819	67.67%	0
Jul 2012	NUB-L3/1207	167,495	205,237	62.65%	0
Total / *Average*		**2,218,331**	**2,826,607**	*66.29%*	**416**

Because the actual biogas generated during the 2nd monitoring period was significantly smaller than the designed amount, the accuracy of biogas flow monitored during the 2nd monitoring period resulted in negative leakage for most months within the said monitoring period. As shown in Table 7 above, the leakage emission for those months when negative leakage was observed was set as zero to ensure conservativeness in determining leakage emissions.

Flow meters were later replaced so that the flow measurement range matches with the actual biogas generation. A two-week monitoring test conducted in July 2013 showed accuracy improvement in monitoring of the biogas flow. The test resulted in 1 to 2 % difference between V_{AD} and V_{TR}, which was within the maximum error range of 4% described in the approved revised PDD as uncertainty level of data. The monitoring test results are summarized in Table 8 below.

Table 8 Results of monitoring test using newly replaced flow meters (July 2013)

Monitoring period (days)	V_{AD} (F-01)	V_{TR} (V_F + V_D)	X_{CH4}	L_{CH4}
	Nm^3	Nm^3	%	tCO_2e
1	5,732	5,445	71.2	3.02
2	5,884	5,623	70.1	2.71
3	5,588	5,299	70.0	3.00
4	4,957	4,899	70.8	0.60
5	4,401	4,266	71.0	1.42

[1] 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%.

6	4,315	4,242	70.1	0.76
7	3,928	3,854	68.4	0.75
8	4,127	4,085	70.0	0.44
9	4,031	3,983	70.1	0.50
10	4,009	3,964	72.0	0.48
11	4,082	4,036	73.9	0.51
12	5,097	5,030	74.8	0.75
13	5,113	5,075	75.4	0.42
14	5,103	5,059	75.8	0.50
Total	**66,368**	**64,860**	**71.7**	**15.84**

For the sake of conservativeness in calculating the leakage emission for the 2nd monitoring period, NUBIKA has adopted the result of the monitoring test above, and recalculated the leakage emission as follows:

L_{y,CH_4} = 15.84 tCO_2e / 64,860 N m^3 x 2,826,607 N m^3 / 2nd monitoring period

= **690 tCO_2e** / 2nd monitoring period

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

Item	Baseline emissions or baseline net GHG removals by sinks (t CO_2e)	Project emissions or actual net GHG removals by sinks (t CO_2e)	Leakage (t CO_2e)	Emission reductions or net anthropogenic GHG removals by sinks (t CO_2e)
Total	27,702	0	690	27,012

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 (t CO_2e)	88,362	27,012

The table above shows the comparison of actual values of the emission reductions achieved during the monitoring period with the estimations in the approved revised CDM-PDD. The annual emission reductions of this project estimated in its approved revised PDD is 44,181 tCO_2e. Thus, for the monitoring period of 2 years, the estimated emission reductions are 88,362 tCO_2e.

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

The emission reductions within the 2nd monitoring period of 01/08/2010 – 31/07/2012 (2 years) is calculated to be **27,012 tCO_2e** (about 30.6% of the *ex-ante* calculation), which is less than 88,362 tCO_2e for 2 years in the approved revised PDD.

The shortage is primarily due to the following reasons:

- The biogas plant was not fully operated in the first half of this monitoring period. Thus, the methane recovered by the plant is not as high as the expectation when it operates in its desired specification. The methane generation rate calculated during the monitoring period is 0.0936 kg CH_4 / kg COD, as compared to the baseline AD of 0.168 kg CH_4 / kg COD (about 55.71%). The project participant plans to continuously work to improve the biogas plant's efficiency together with the cooperation of technology provider to optimize the operation of the biogas plant.

- The plant operation by use of LPG as feedstock for the hydrogen plant was delayed until April 2012 due to the technical difficulties to reduce H_2S and moisture contents in the biogas to the required level. Thus, emission reductions attributed to the displacement of LPG in hydrogen production plant are only achieved from April 2012 onwards.

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

In conclusion, the management of PT Nubika Jaya believes that it has implemented the project in accordance with its approved revised 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.

E.7. Actual emission reductions or net anthropogenic GHG removals by sinks during the first commitment period and the period from 1 January 2013 onwards

Item	Actual values achieved up to 31 December 2012	Actual values achieved from 1 January 2013 onwards
Emission reductions or GHG removals by sinks (t CO_2e)	27,012	–

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