



**Monitoring report form for CDM project activity  
(Version 06.0)**

*Complete this form in accordance with the instructions attached at the end of this form.*

**MONITORING REPORT**

<b>Title of the project activity</b>	Double A Ethanol wastewater treatment plant	
<b>UNFCCC reference number of the project activity</b>	9394	
<b>Version number of the PDD applicable to this monitoring report</b>	Version 04	
<b>Version number of this monitoring report</b>	Version 01	
<b>Completion date of this monitoring report</b>	19/10/2018	
<b>Monitoring period number</b>	Third monitoring period	
<b>Duration of this monitoring period</b>	01/07/2017 to 30/06/2018	
<b>Monitoring report number for this monitoring report</b>	-	
<b>Project participants</b>	Double A Ethanol Company Limited. Asian Development Bank, as Trustee of the Future Carbon Fund; Swedish Energy Agency	
<b>Host Party</b>	Thailand	
<b>Sectoral scopes</b>	13	
<b>Applied methodologies and standardized baselines</b>	ACM0014 – Treatment of Wastewater, version 05	
<b>Amount of GHG emission reductions or net anthropogenic GHG removals achieved by the project activity in this monitoring period</b>	<b>Amount achieved before 1 January 2013</b>	<b>Amount achieved from 1 January 2013</b>
	0 tCO <sub>2e</sub>	65,791 tCO <sub>2e</sub>
<b>Amount of GHG emission reductions or net anthropogenic GHG removals estimated ex ante for this monitoring period in the PDD</b>	204,921 tCO <sub>2e</sub>	

## SECTION A. Description of project activity

### A.1. General description of project activity

“Double A Ethanol wastewater treatment plant”, hereafter referred to as ‘the Project’ is implemented by Double A Ethanol Company Limited (aAE) for treating industrial wastewater from the aAE Ethanol plant. The project is located in Prachinburi, Thailand. This is Greenfield project activity.

The purpose of project activity is to treat the wastewater from the ethanol plant to generate biogas. The project activity entails the installation of an anaerobic digester system with biogas collection equipment and utilising biogas for thermal generation. The biogas recovered is supplied to the boiler of an adjacent limekiln which is partly replacing fuel oil (Bunker C) for heat generation. The project activity results to GHG emission reductions due to methane avoidance from anaerobic open lagoons and avoidance of carbon dioxide emissions from fuel oil combustion in the limekiln.

### A.2. Location of project activity

The project is located within 304 Industrial Estate in Prachinburi, Thailand. The physical address is 1 Moo 2 Tha-toom sub-district, Srimahaphote District, Prachinburi Province, Thailand. Figure 1 shows the project location map. The geographical location is below;

Latitude: N 13 54 53.3

Longitude: E 101 34 20.4

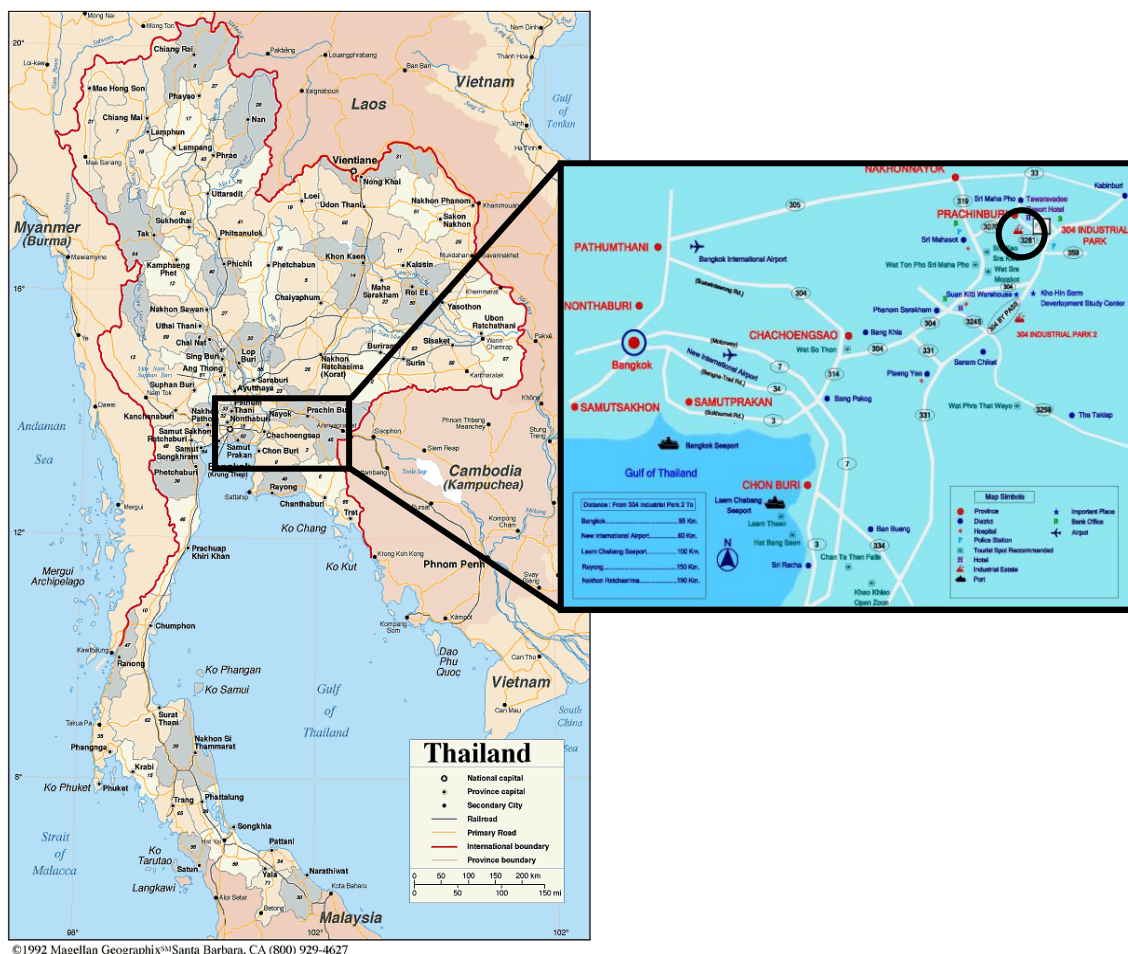


Figure 1: Project Location

**A.3. Parties and project participants**

Parties involved	Project participants	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
Thailand (host Party)	Double A Ethanol Company Limited. (Private entity)	No
Sweden	Asian Development Bank, as Trustee of the Future Carbon Fund; Swedish Energy Agency (Public entity)	No

**A.4. Reference to applied methodologies and standardized baselines**

The applied methodology is ACM0014 – “Treatment of wastewater” version 05 (EB68).  
Reference to the methodology applied in the project activity:

<http://cdm.unfccc.int/methodologies/DB/AUUM6YRNM6XUV213IOGNI1G9ITGRN1>

Tools applied in the project activity are;

- Tool for the demonstration and assessment of additionality (version 06.1)
- Project emission from flaring (version 2)
- Project and leakage emissions from anaerobic digesters (version 01)
- Tool to determine the mass flow of a greenhouse gas in a gaseous stream (version 2)
- Tool to calculate baseline, project and/or leakage emission from electricity consumption (version 01)
- Tool to calculate emission factor for an electricity system (version 02.2.1)

Reference to the tools applied in the project activity:

<http://cdm.unfccc.int/methodologies/PAmethodologies/tools/>

**A.5. Crediting period type and duration**

Type of crediting period: fixed crediting period

Start date of crediting period: 01/04/2014 to 31/03/2024

Length of crediting period: 10 years

Current monitoring period: 01/07/2017 to 30/06/2018

Length of the current monitoring period: 1 year

**SECTION B. Implementation of project activity****B.1. Description of implemented project activity**

The ethanol plant has a production capacity of 500,000 litres per day from cassava. The wastewater from ethanol production process is 5,000 m<sup>3</sup>/day with COD of 42,000 mg/L. In the baseline scenario, the wastewater would have been treated in an open anaerobic lagoon system. The traditional open system would be sufficient to treat the wastewater and not have any biogas recovery.

In the project activity, the wastewater is treated in an anaerobic digester system combined with an aerobic treatment. The biogas captured is used for thermal generation in the limekiln. In any emergency case, the excess biogas is flared in the flaring system. The proposed project activity results in emission reductions from the avoidance of methane emissions from the anaerobic open

lagoon and the avoidance of carbon dioxide emissions from the combustion of fuel oil in the limekiln.

### Technical description:

The technology installed under the project activity is the combination of anaerobic and aerobic treatment. The major components of project activity as follows;

#### *Wastewater treatment:*

Wastewater from the ethanol plant is initially directed to an Internal Circulation Reactor (IC Reactor) anaerobic digester system. There are three IC reactor tanks. The tanks perform anaerobic fermentation where most of COD and organic suspended solid substance are converted into biogas. The removal rate of COD under this system is 90%. The IC Reactor treatment stage can recover 59,505 m<sup>3</sup> of methane per day.

The wastewater is then forwarded to an aerobic treatment system that consists of three aerobic tanks. In the process of aerobic treatment, most of organic substances are decomposed; the treatment efficiency of COD is 90% of COD input<sup>1</sup>. After the aerobic treatment wastewater will pass through a clarifier. Then, the treated wastewater is discharged into the irrigation pond of the 304 industrial park.

#### *Sludge:*

Sludge is partly refluxed into the aerobic and anaerobic treatment stages to enhance wastewater treatment conditions. The excess sludge is collected in a sludge-thickening tank that separates wastewater and sludge by gravitational sedimentation. This sludge is pumped to a belt press. Then, a conveyor transfers the sludge to a storage area where sludge is transported to farmers and collectors for further processing as fertilizer or for land application on the field. The wastewater from the sludge thickening tank and belt press is also treated to meet the wastewater discharge standard.

#### *Biogas recovery:*

The biogas production is 79,340 m<sup>3</sup>/day with methane content of 59,505 m<sup>3</sup>/day. The biogas recovered is treated in the biogas treatment system. The biogas is utilised in the boiler of the adjacent limekiln for thermal generation that partly displace the fuel oil (bunker oil C). Any excess biogas is flared in the flaring system.

The brief description of the installed technologies is provided in the table 1. The project diagram is shown in the figure 2.

### Implementation status of the project activity during the monitoring period:

The details of implementation and actual operation of project activity, which conducted in this monitoring period, is provided in the table 1. The data monitoring of the project activity was carried out as described in the registered PDD.

Table 1: the operation status of project activity

Event	Date	References
The project owner signed contract with the technology provider.	24/12/2007	Contract between Double A Ethanol Co., Ltd. and Siemens.
Registration under CDM scheme	31/12/2012	UNFCCC website
Commissioning of project activity (COD – Commercial operation)	21/03/2014	Acceptance of performance certificates

<sup>1</sup> EPC contract AGT007-2550 (pg 69)

date)		
1 <sup>st</sup> monitoring period	01/04/2014 to 30/06/2016	Refer to the first monitoring report version 02
Installation of additional enclosed flare system	14/09/2016	Refer to purchase order document
2 <sup>nd</sup> monitoring period	01/07/2016 to 30/06/2017	Refer to the second monitoring report version 05
3 <sup>rd</sup> monitoring period	01/07/2017 to 30/06/2018	Refer to this report

Further information in this period, the calibration of the equipment was conducted as per the registered monitoring plan. In case of calibration delay, the measured values during the delay period are adjusted by applying an identified error or maximum permissible error as the case may be in a calibration report in a conservative manner, which is in line with the latest version of clean development mechanism validation and verification standard (VVS).

Table 2: The description of the installed technology and equipment;

Equipment	Manufacturer / Technology provider	Type/Model	Specifications
Wastewater treatment system	Siemens Thailand	<ul style="list-style-type: none"> <li>Anaerobic digester system: an Internal Circulation Reactor (IC Reactor)</li> <li>Aerobic treatment system</li> </ul>	The biogas system has a designed COD reduction efficiency of 90%. The expected biogas production is around 79,340 m <sup>3</sup> per day (at 59,505 m <sup>3</sup> of CH <sub>4</sub> ).
Flaring system	Siemens/Verec	Open flare (3 units)	Model: 244WL0391200 A maximum capacity of 2,530 Nm <sup>3</sup> /hr for each unit
	Napatr Service	Enclosed flare (2 units)	Model: NS-500 Bio A capacity of 500 Nm <sup>3</sup> /hr for each unit

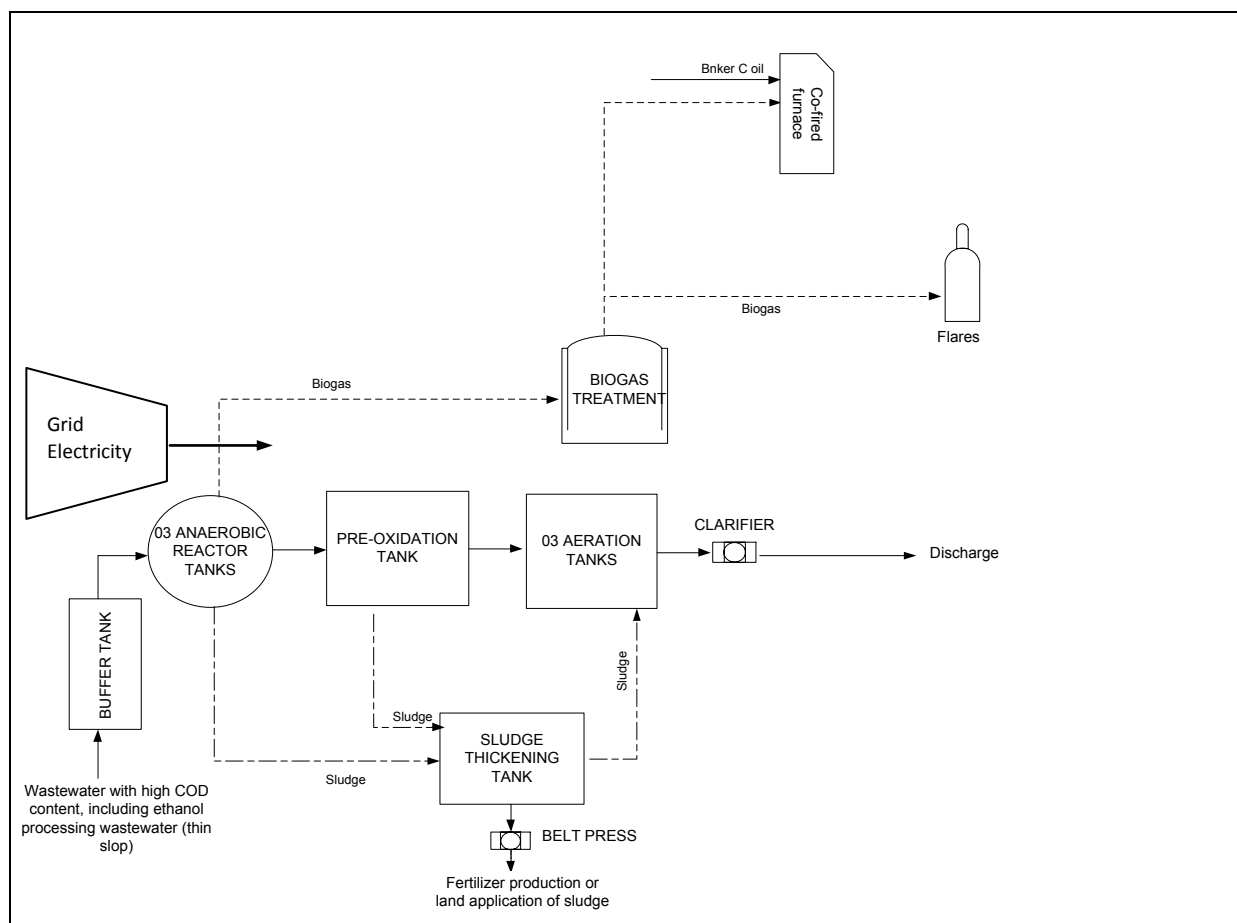


Figure 2: Project Diagram

## B.2. Post-registration changes

### B.2.1. Temporary deviations from the registered monitoring plan, applied methodologies or standardized baselines

No temporary deviations from registered monitoring plan or applied methodology during the monitoring period.

### B.2.2. Corrections

There are corrections to project information or parameters fixed at the registration of the project activity. PP has updated the Global warming potential for CH<sub>4</sub> (from 21 to 25) corresponding to the Ex-ante parameter “GWP<sub>CH<sub>4</sub></sub>” fixed at registration of the CDM project activity as described in the registered PDD. The ex-ante emission reductions have been changed from 170,983 tCO<sub>2</sub>e to 204,921 tCO<sub>2</sub>e.

PRC status: Approved

The approval date: 18/02/2018

Reference: PRC-9394-001

Link: <https://cdm.unfccc.int/PRCContainer/DB/prcp980757293/view>

### B.2.3. Changes to the start date of the crediting period

The start date of crediting period is changed from “31/03/2013 - 30/03/2023” to “01/04/2014 - 31/03/2024”. The notification has been sent to CDM registration team on 18/10/2016.

**B.2.4. Inclusion of monitoring plan**

None of inclusion of a monitoring plan to registered PDD is considered during this current monitoring period.

**B.2.5. Permanent changes to the registered monitoring plan, or permanent deviation of monitoring from the applied methodologies, standardized baselines, or other applied standards or tools**

There are permanent changes to the registered monitoring plan including the applied tools. Referring to section B.2.6, installation of additional enclosed flare system has completed in the project activity since September 2016. Because of this change, the monitoring plan has been revised in compliance with “Project emissions from flaring version 02.0.0”. An ex-ante parameter “SPECflare” has been included under the section B.6.2 of the revised PDD and also revised section B.6.1 of the revised PDD. This is in line with the applied tool. The manufacturer’s flare specifications along with Minimum and maximum inlet flow rate/operating temperature have been included in the PDD.

PRC status: Approved

The approval date: 18/02/2018

Reference: PRC-9394-001

Link: <https://cdm.unfccc.int/PRCContainer/DB/prcp980757293/view>

**B.2.6. Changes to project design**

There was a change in project design that approved by CDM EB already. The change has involved with the additional installation of two units of enclosed flare system. The enclosed flares have been under operation since September 2016. The actual changes do not adversely impact any of these:

- (a) The applicability and application of the applied methodology i.e. “ACM0014 version 05 – Treatment of wastewater”
- (b) The compliance of the monitoring plan with the applied methodologies;
- (c) The level of accuracy and completeness in the monitoring of the project activity compared with the requirements contained in the registered monitoring plan;
- (d) The additionality of the project activity;
- (e) The scale of the project activity.

PRC status: Approved

The approval date: 18/02/2018

Reference: PRC-9394-001

Link: <https://cdm.unfccc.int/PRCContainer/DB/prcp980757293/view>

**SECTION C. Description of monitoring system***Monitoring Procedure:*

Monitoring data is recorded/downloaded monthly and stored electronically in a database. Any problem with the monitoring equipment is noted in an operation and maintenance log-book and entered into the database. A monitoring data report is produced containing the monthly monitoring data files and details of any equipment faults and/or loss of data. The monitoring data report is submitted to the plant manager to review and acceptance. All records are retained for at least two years after the end of the crediting period. In case no monitoring records are available, no emission reduction is claimed for that specific period.

*Quality Assurance:*

The following quality assurance measures are taken relating to the monitoring equipment and its installation and operation;

- All meters, sensing and sampling equipment are designed and manufactured to International standards.
- Prior to operation, aAE validated that the monitoring equipment is calibrated according to the appropriate standards.
- The central control system for managing the data requirement of the biogas plant is located in a secure, sealed housing to prevent damage or tampering.
- Routine maintenance and calibration including inspection of all monitoring equipment are performed in accordance with the manufacturer's specification if applicable to ensure that the data remains accurate.

To ensure the quality of the recorded data, all personnel are trained in accordance with this monitoring plan. The following quality assurance measures are taken relating to the storage and recording of the monitored data.

- A paper backup of the monthly electronic data file is stored in a secure location onsite.
- The monitored data files are included as part of the operation report and electronic backup of the report is reviewed and approved by plant manager.

*Data storage:*

All the data are transferred online to the computer. Storage of data is onsite, on digital storage devices/media with hardcopies as physical backup. The monitoring data is weekly backup to secondary digital storage devices. The data is approved by plant manager and kept for a minimum two years following end of crediting period.

*Quality control procedure:*

To ensure malfunction is identified promptly, all monitoring equipment is manually inspected on a monthly basis. Any equipment faults or loss of data are recorded in the database with detail of the fault and length of time over which data was affected.

*Operational and Management Structure:*

aAE is responsible for the on-site monitoring and implementation of the quality assurance and quality control procedures and compiling the CDM monitoring report for Verification. The operational and management structure that are implemented to monitor emission reductions described in the following diagram.

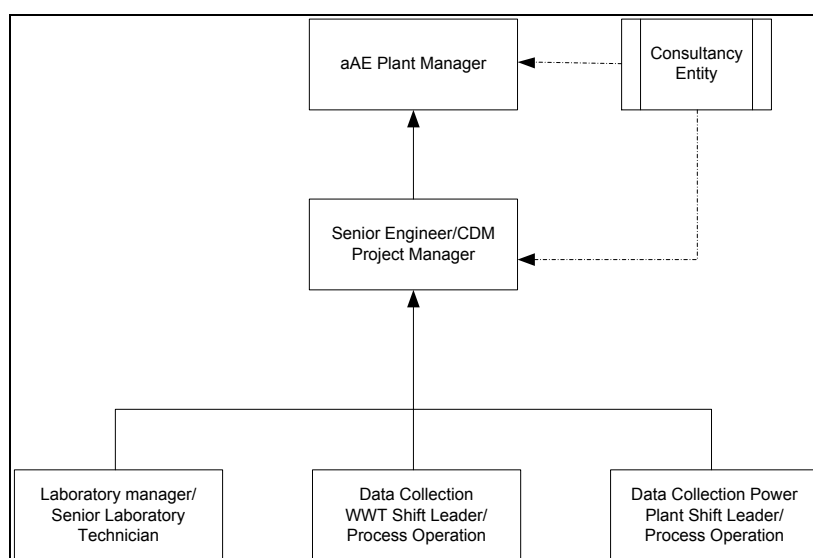


Figure 3: Monitoring organization



## Flow diagram of current implementation of project activity

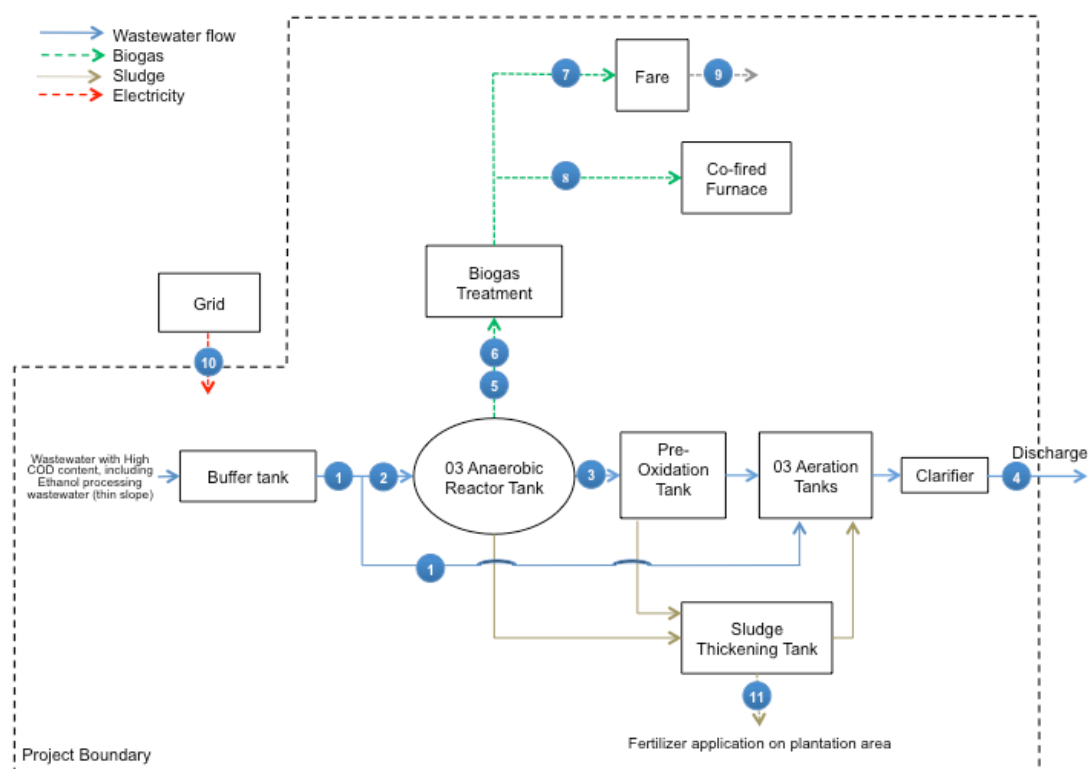


Figure 4: Monitoring Diagram

Table 3: Monitoring points

No.	Parameters	Description
1	$F_{PJ,dig,m}$	Quantity of wastewater that is treated in the anaerobic digester system
2	$COD_{dig,m}$	Chemical oxygen demand in the wastewater that is treated in the anaerobic digester
3	$COD_{eff,m}$	Chemical oxygen demand in the wastewater after treatment in the anaerobic digester
4	$COD_{discharge,m}$	Chemical oxygen demand in the wastewater discharged
5	$F_{biogas,y}/N_{t,db}$	Total amount of biogas collected in the outlet of the new digester
6	$W_{CH4,biogas,y}$	Concentration of methane in the total biogas supply in the outlet of the new digester
7	$F_{biogas,flare,y}$	The volumetric flow of biogas sent to flare
8	$F_{biogas,KLIN,y}$	The volumetric flow of biogas sent to boiler
9	$T_{flare}$	Temperature in the exhaust gas of the flare
10	$EC_{PJ,y}$	Amount of electricity in the year y that is consumed at the project site for the project activity
11	$S_{LA,y}$	Amount of sludge applied to land in month

## SECTION D. Data and parameters

### D.1. Data and parameters fixed ex ante

Data/Parameter	$COD_{out,x}$
Unit	Ton COD
Description	COD of the effluent in the period x
Source of data	As per Report on Anaerobic Lagoon, the design COD inflow for COD in and the design effluent COD flow for COD out are used for corresponding to the design features of the lagoon system identified in the procedure for the selection of the baseline scenario
Value(s) applied	120 mg/L
Choice of data or measurement methods and procedures	The proposed project activity involves the installation of new anaerobic digester and biogas facilities as Greenfield facilities. The design value in the baseline lagoon design in the section "Identification of alternative scenarios" is used. The unit of parameter will be converted to ton COD/year with the simple unit conversion factor.
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	-

Data/Parameter	$COD_{in,x}$
Unit	ton COD
Description	COD directed to the open lagoons (Scenario 1)
Source of data	As per Report on Anaerobic Lagoon, the design effluent COD flow for COD out is used for corresponding to the design features of the lagoon system identified in the procedure for the selection of the baseline scenario
Value(s) applied	42,000 mg/L
Choice of data or measurement methods and procedures	The proposed project activity involves the installation of new anaerobic digester and biogas facilities as Greenfield facilities. The design value in the baseline lagoon design in the section "Identification of alternative scenarios" is used. The unit of parameter is converted to ton COD/year with the simple unit conversion factor.
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	-

Data/Parameter	$B_0$
Unit	tCH <sub>4</sub> /tCOD
Description	Maximum methane producing capacity, expressing the maximum amount of CH <sub>4</sub> that can be produced from a given quantity of chemical oxygen demand (COD)
Source of data	ACM0014 (version 05.0.0) 2006 IPCC Guidelines default value.
Value(s) applied	0.21
Choice of data or measurement methods and procedures	No measurement procedure. The default IPCC value for $B_0$ is 0.25 kgCH <sub>4</sub> /kg COD. If the methodology is used for wastewater containing materials not akin to simple sugars, a CH <sub>4</sub> emissions factor different from 0.21 tCH <sub>4</sub> /tCOD has to be estimated and applied.
Purpose of data/parameter	Calculation of baseline and project emissions
Additional comments	Taking into account the uncertainty of this estimate, a value of 0.21 kgCH <sub>4</sub> /kgCOD is used as a conservative assumption for $B_0$ and the unit is converted to tCH <sub>4</sub> /tCOD with the simple unit conversion factor.

<b>Data/Parameter</b>	<b><math>f_d</math></b>
Unit	%
Description	Factor expressing the influence of the depth of the lagoon or sludge pit on methane generation
Source of data	ACM0014 (version 05.0.0) Apply the following values for the corresponding average depth of the open lagoon: If $D < 1\text{m}$ - 0 If $1\text{m} < D < 2\text{m}$ - 0.5 If $D > 2\text{m}$ - 0.7
Value(s) applied	0.7 (As the Report on Anaerobic lagoon specifies the depth of lagoon to be $D = 6\text{m}$ )
Choice of data or measurement methods and procedures	No measurement procedure
Purpose of data/parameter	Calculation of baseline and project emissions
Additional comments	The project activity implemented in Greenfield facilities where the baseline is a new to be built anaerobic lagoon, use the depth as defined in the baseline lagoon design in the section "Identification of alternative scenarios".

<b>Data/Parameter</b>	<b><math>EF_{\text{grid},y} / EF_{\text{EL},j,y}</math></b>
Unit	tCO <sub>2</sub> /MWh
Description	Grid emission factor in year (Combined Emission factor)
Source of data	Tool to calculate the emission factor for an electricity system (version 02.1.1)
Value(s) applied	0.5113
Choice of data or measurement methods and procedures	Tool to calculate emission factor for an electricity system (version 02.1.1) The study of emission factor for an electricity system in Thailand 2011, <a href="http://www.tgo.or.th/english/index.php?option=com_content&amp;view=article&amp;id=178:thailand-grid-emission-2010-report&amp;catid=50:tgos-research-projects&amp;Itemid=40">http://www.tgo.or.th/english/index.php?option=com_content&amp;view=article&amp;id=178:thailand-grid-emission-2010-report&amp;catid=50:tgos-research-projects&amp;Itemid=40</a>
Purpose of data/parameter	Calculation of project emissions
Additional comments	Included as a part of this PDD as Annex 3

<b>Data/Parameter</b>	<b>D</b>
Unit	m
Description	Average depth of the lagoon or sludge pit
Source of data	Report on Anaerobic lagoon. For project activities implemented in Greenfield facilities: As per the baseline lagoon design as identified in Step 1 of the section "Procedure for the identification of the most plausible baseline scenario Identification of alternative scenarios"
Value(s) applied	6
Choice of data or measurement methods and procedures	Determine the average depths of the whole lagoon/sludge pit under normal operating condition.
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	The project activity implemented in Greenfield facilities where the baseline is a new to be built anaerobic lagoon, use the depth as defined in the baseline lagoon design in the section "Procedure for the identification of the most plausible baseline scenario Identification of alternative scenarios"

Data/Parameter	$\rho$
Unit	-
Description	Discount factor for historical information
Source of data	ACM0014 (version 05.0.0) For existing plants: • If one year of historical data is available $\rho = 1$ ; • If a measurement campaign of at least 10 days is available $\rho = 0.89$ . For Greenfield projects: $\rho = 1$
Value(s) applied	1
Choice of data or measurement methods and procedures	The value of 0.89 for the case where there is no one year historical data is to account for the uncertainty range (of 30% to 50%) associated with this approach as compared to one-year historical data.
Purpose of data/parameter	Calculation of project emissions
Additional comments	Normal conditions are defined as 20°C and 1 atm pressure

Data/Parameter	$TDL_y$
Unit	%
Description	Average technical transmission and distribution losses for providing electricity to source in year y
Source of data	Tool to calculate baseline, project and/or leakage emissions from electricity consumption (version 01)
Value(s) applied	20
Choice of data or measurement methods and procedures	Scenario C, Case C.III applies to the project. No data is available from the host country and the project activity electricity consumption is greater than. Therefore the default value of 20% is applied.
Purpose of data/parameter	Calculation of project emissions
Additional comments	-

Data/Parameter	$EF_{N_2O, LA, sludge}$
Unit	tN <sub>2</sub> O/tN
Description	N <sub>2</sub> O emission factor for nitrogen from sludge applied to land
Source of data	ACM0014 (version 05.0.0) Stehfest, E. and Bouwman, A.F. N <sub>2</sub> O and NO emission from agricultural fields and soils under natural vegetation: summarizing available measurement data and modelling of global annual emissions. Nutr. Cycl. 29 Agroecosyst., in press. The average emission factor used is 0.01 kg N <sub>2</sub> O-N / kg N (= 0.016 kg N <sub>2</sub> O / kg N)
Value(s) applied	0.016
Choice of data or measurement methods and procedures	No measurement procedures.
Purpose of data/parameter	Calculation of project emissions
Additional comments	Applicable if sludge is applied on land under the project activity.

Data/Parameter	$MCF_{sludge, LA}$
Unit	-
Description	Methane conversion factor for the application of sludge to lands
Source of data	ACM0014 (version 05.0.0)
Value(s) applied	0.05

Choice of data or measurement methods and procedures	No measurement procedures. Value to be applied 0.05
Purpose of data/parameter	-
Additional comments	-

<b>Data/Parameter</b>	<b>GWP<sub>CH4</sub></b>
Unit	tCO <sub>2e</sub> /tCH <sub>4</sub>
Description	Global warming potential for CH <sub>4</sub>
Source of data	IPCC
Value(s) applied	25 – for the second commitment period
Choice of data or measurement methods and procedures	Default value
Purpose of data/parameter	Calculation of project and baseline emissions
Additional comments	*According EB 69 - Annex 3, the 2nd commitment period GWP shall be effective from 01/01/2013.

<b>Data/Parameter</b>	<b>GWP<sub>N2O</sub></b>
Unit	tCO <sub>2e</sub> /N <sub>2</sub> O
Description	Global warming potential for N <sub>2</sub> O
Source of data	IPCC
Value(s) applied	296
Choice of data or measurement methods and procedures	Default value
Purpose of data/parameter	Calculation of project emissions
Additional comments	This parameter shall be update according to any future COP/MOP decisions.

<b>Data/Parameter</b>	<b>f<sub>CH4,default</sub></b>
Unit	Nm <sup>3</sup> CH <sub>4</sub> / Nm <sup>3</sup> biogas
Description	Default value for the fraction of methane in the biogas
Source of data	Project and leakage emissions from anaerobic digesters (version 01.0.0) The default value was derived based on reported values from registered projects and research papers (Davidsson, 2007)
Value(s) applied	0.6
Choice of data or measurement methods and procedures	-
Purpose of data/parameter	Calculation of project emissions
Additional comments	This value is used for Option 2 of the step. Determination of the quantity of methane produced in the digester.

<b>Data/Parameter</b>	<b>pCH<sub>4</sub></b>
Unit	t CH <sub>4</sub> / Nm <sup>3</sup> CH <sub>4</sub>
Description	Density of methane at normal conditions
Source of data	Project and leakage emissions from anaerobic digesters (version 01.0.0) Technical literature
Value(s) applied	0.00067

Choice of data or measurement methods and procedures	-
Purpose of data/parameter	Calculation of project emissions
Additional comments	Normal conditions are defined as 20°C and 1 atm pressure

<b>Data/Parameter</b>	<b>EF<sub>CH4,default</sub></b>
Unit	t CH <sub>4</sub> leaked / t CH <sub>4</sub> produced
Description	Default emission factor for the fraction of CH <sub>4</sub> produced that leaks from the anaerobic digester
Source of data	Project and leakage emissions from anaerobic digesters (version 01.0.0) IPCC (2006), Flesch et al. (2011) and Kurup (2003)
Value(s) applied	Use the default value corresponding to the type of digester used in the project activity. The digester type shall be identified by manufacturer information. If this is not possible, then the factor 0.1 shall be applied (upper range of the IPCC values). <ul style="list-style-type: none"> <li>• 0.028: Digesters with steel or lined concrete or fiberglass digesters and a gas holding system (egg shaped digesters) and monolithic construction;</li> <li>• <b>0.05</b>: UASB type digesters, floating gas holders with no external water seal; (This value is applied as the IC reactor is a type of UASB type digester)</li> <li>• 0.10: Digesters with unlined concrete/ferrocement/brick masonry arched type gas holding section; monolithic fixed dome digesters, covered anaerobic lagoon.</li> </ul>
Choice of data or measurement methods and procedures	-
Purpose of data/parameter	Calculation of project emissions
Additional comments	-

<b>Data/Parameter</b>	<b>Ru</b>
Unit	Pa.m <sup>3</sup> /kmol.K
Description	Universal ideal gases constant
Source of data	Tool to determine the mass flow of a greenhouse gas in a gaseous stream (version 2.0.0)
Value(s) applied	8,314
Choice of data or measurement methods and procedures	-
Purpose of data/parameter	Calculation of baseline/project emissions
Additional comments	-

Data/Parameter	MMi		
Unit	kg/kmol		
Description	Molecular mass of greenhouse gas i (CH <sub>4</sub> )		
Source of data	Tool to determine the mass flow of a greenhouse gas in a gaseous stream (version 2.0.0)		
Value(s) applied			
	Compound	Structure	Molecular mass (kg/mol)
	Carbon dioxide	CO2	44.01
	Methane	CH4	16.04
	Nitrous oxide	N2O	44.02

Choice of data or measurement methods and procedures	-
Purpose of data/parameter	Calculation of baseline/project emissions
Additional comments	-

<b>Data/Parameter</b>	<b>P<sub>n</sub></b>
Unit	Pa
Description	Total pressure at normal conditions
Source of data	Tool to determine the mass flow of a greenhouse gas in a gaseous stream (version 2.0.0)
Value(s) applied	101,325 Pa
Choice of data or measurement methods and procedures	-
Purpose of data/parameter	Calculation of baseline/project emissions
Additional comments	-

<b>Data/Parameter</b>	<b>T<sub>n</sub></b>
Unit	K
Description	temperature at normal conditions
Source of data	Tool to determine the mass flow of a greenhouse gas in a gaseous stream (version 2.0.0)
Value(s) applied	273.15 K
Choice of data or measurement methods and procedures	-
Purpose of data/parameter	Calculation of baseline/project emissions
Additional comments	-

<b>Data/Parameter</b>	<b>T<sub>1</sub></b>
Unit	K
Description	Temperature
Source of data	ACM0014 (version 05.0.0) (page 12)
Value(s) applied	303.16 K (273.16 K + 30 K)
Choice of data or measurement methods and procedures	-
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	-

<b>Data/Parameter</b>	<b>R</b>
Unit	cal/K mol
Description	Ideal gas constant
Source of data	ACM0014 (version 05.0.0) (page 12)
Value(s) applied	1.987

Choice of data or measurement methods and procedures	-
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	-

<b>Data/Parameter</b>	<b>E</b>
Unit	cal/mol
Description	Activation energy constant
Source of data	ACM0014 (version 05.0.0) (page 12)
Value(s) applied	15,175
Choice of data or measurement methods and procedures	-
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	-

<b>Data/parameter:</b>	<b>SPEC<sub>flare</sub></b>
Data unit	Temperature - °C Flow rate – kg/hr or m3/h
Description	Manufacturer's flare specifications for temperature and flow rate
Source of data	Flare manufacturer
Value(s) applied)	Minimum and maximum of operating temperature: 500 – 1,100 °C Minimum and maximum of Flow rate: 0 – 500 Nm3/h
Choice of data or measurement methods and procedures	The measurement is conducted as per the manual recommended by manufacturer.
Purpose of data	Calculation of project emissions
Additional comments	The option A of enclosed flare operation of the project emissions from flaring tool is selected to determine the flare efficiency in the project activity. This parameter is considered for determination of flare efficiency of enclosed flare system.



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

Data/Parameter	$F_{PJ,dig,m}$																																											
Unit	m <sup>3</sup> / month																																											
Description	Quantity of wastewater that is treated in the anaerobic digester or under clearly aerobic conditions in the project activity in month m																																											
Measured/calculated/default	Measured (Continuously)																																											
Source of data	Plant records																																											
Value(s) of monitored parameter	<table><tr><th rowspan="2">Month</th><th colspan="2">Total value (m<sup>3</sup>)</th></tr><tr><th>2017</th><th>2018</th></tr><tr><td>1</td><td>-</td><td>172,228</td></tr><tr><td>2</td><td>-</td><td>160,514</td></tr><tr><td>3</td><td>-</td><td>174,275</td></tr><tr><td>4</td><td>-</td><td>74,258</td></tr><tr><td>5</td><td>-</td><td>Plant shut down</td></tr><tr><td>6</td><td>-</td><td>Plant shut down</td></tr><tr><td>7</td><td>229,214</td><td>-</td></tr><tr><td>8</td><td>208,436</td><td>-</td></tr><tr><td>9</td><td>231,691</td><td>-</td></tr><tr><td>10</td><td>228,101</td><td>-</td></tr><tr><td>11</td><td>222,888</td><td>-</td></tr><tr><td>12</td><td>196,516</td><td>-</td></tr></table>			Month	Total value (m <sup>3</sup> )		2017	2018	1	-	172,228	2	-	160,514	3	-	174,275	4	-	74,258	5	-	Plant shut down	6	-	Plant shut down	7	229,214	-	8	208,436	-	9	231,691	-	10	228,101	-	11	222,888	-	12	196,516	-
	Month	Total value (m <sup>3</sup> )																																										
		2017	2018																																									
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Monitoring equipment	<table border="1"> <tr><td>Meter tag</td><td>FT153</td></tr> <tr><td>Equipment Type</td><td>Magnetic flow meter</td></tr> <tr><td>Manufacturer</td><td>Siemens</td></tr> <tr><td>Model</td><td>FM MAG6000</td></tr> <tr><td>Maximum permissible error</td><td><math>\pm 0.20\%^2</math></td></tr> <tr><td>Serial No.</td><td>493202H372</td></tr> <tr><td>Calibration Frequency</td><td>Once in three years</td></tr> <tr><td>Date of latest calibration</td><td>28/05/2016</td></tr> <tr><td>Date of validity</td><td>27/05/2019</td></tr> <tr><td>Installation date</td><td>COD<sup>3</sup> to present</td></tr> </table>	Meter tag	FT153	Equipment Type	Magnetic flow meter	Manufacturer	Siemens	Model	FM MAG6000	Maximum permissible error	$\pm 0.20\%^2$	Serial No.	493202H372	Calibration Frequency	Once in three years	Date of latest calibration	28/05/2016	Date of validity	27/05/2019	Installation date	COD <sup>3</sup> to present
	Meter tag	FT153																			
Equipment Type	Magnetic flow meter																				
Manufacturer	Siemens																				
Model	FM MAG6000																				
Maximum permissible error	$\pm 0.20\%^2$																				
Serial No.	493202H372																				
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Date of validity	27/05/2019																				
Installation date	COD <sup>3</sup> to present																				
<table border="1"> <tr><td>Meter tag</td><td>FT155</td></tr> <tr><td>Equipment Type</td><td>Magnetic flow meter</td></tr> <tr><td>Manufacturer</td><td>Siemens</td></tr> <tr><td>Model</td><td>FM MAG6000</td></tr> <tr><td>Maximum permissible error</td><td><math>\pm 0.20\%</math></td></tr> <tr><td>Serial No.</td><td>493302H372</td></tr> <tr><td>Calibration Frequency</td><td>Once in three years</td></tr> <tr><td>Date of latest calibration</td><td>28/05/2016</td></tr> <tr><td>Date of validity</td><td>27/05/2019</td></tr> <tr><td>Installation date</td><td>COD to present</td></tr> </table>	Meter tag	FT155	Equipment Type	Magnetic flow meter	Manufacturer	Siemens	Model	FM MAG6000	Maximum permissible error	$\pm 0.20\%$	Serial No.	493302H372	Calibration Frequency	Once in three years	Date of latest calibration	28/05/2016	Date of validity	27/05/2019	Installation date	COD to present	
Meter tag	FT155																				
Equipment Type	Magnetic flow meter																				
Manufacturer	Siemens																				
Model	FM MAG6000																				
Maximum permissible error	$\pm 0.20\%$																				
Serial No.	493302H372																				
Calibration Frequency	Once in three years																				
Date of latest calibration	28/05/2016																				
Date of validity	27/05/2019																				
Installation date	COD to present																				
Measuring/reading/recording frequency	The monitoring data was measured continuously using magnetic flow meters. The data were recorded daily into the log-sheets during this monitoring period. The daily data were summarised and integrated into the spreadsheets monthly. The daily data were applied in the calculation of emission reductions. In addition, the monitoring value was also recorded by computer control system as data backup.																				
Calculation method (if applicable)	There were two flow meters measured quantity of wastewater that was treated in anaerobic digester system in the project. The meter tags were FT -153 and FT -155. The meter: FT-153 monitored untreated wastewater from the ethanol production before entering to digester system. In case the digester system was not able to receive untreated effluent, the meter: FT-155 monitored untreated wastewater that bypassed to the secondary aerobic system. The meter FT-155 was installed after the meter FT-153 but before the aeration tank. Therefore, the quantity wastewater that was treated in the anaerobic digester system was considered as the volume of untreated wastewater measured by FT-153 minus the volume of untreated wastewater measured by FT-155.																				
QA/QC procedures	As per the registered PDD, the flow meter shall be calibrated once in three years or as per the manufactures specification in accordance to appropriate industry standards to ensure accuracy.																				
Purpose of data/parameter	Calculation of baseline and project emissions																				
Additional comments	The calibration certificates of two meters were valid in this monitoring period.																				

<b>Data/Parameter</b>	<b>COD<sub>dig,m</sub></b>
<b>Unit</b>	tCOD/m <sup>3</sup>

<sup>2</sup> <http://w3.siemens.com/mcms/sensor-systems/en/process-instrumentation/flow-measurement/electromagnetic/pulsed-dc-meters/transmitters/Pages/sitrans-f-m-mag-6000.aspx#Description>

<sup>3</sup> Commercial operation date

Description	Chemical oxygen demand in the wastewater that is treated in the anaerobic digester or under clearly aerobic conditions in the project activity in month m.																																																									
Measured/calculated/default	Measured																																																									
Source of data	Laboratory test (internal and external)																																																									
Value(s) of monitored parameter	<table border="1"> <thead> <tr> <th rowspan="3">Month</th><th colspan="3">Average value (tCOD/m<sup>3</sup>)</th></tr> <tr> <th colspan="2">2017</th><th rowspan="2">2018</th></tr> <tr> <th>(lower value)</th><th>Higher value</th></tr> </thead> <tbody> <tr><td>1</td><td>-</td><td>-</td><td>0.0256</td></tr> <tr><td>2</td><td>-</td><td>-</td><td>0.0308</td></tr> <tr><td>3</td><td>-</td><td>-</td><td>0.0283</td></tr> <tr><td>4</td><td>-</td><td>-</td><td>0.0320</td></tr> <tr><td>5</td><td>-</td><td>-</td><td>Plant shut down</td></tr> <tr><td>6</td><td>-</td><td>-</td><td>Plant shut down</td></tr> <tr><td>7</td><td>0.0325</td><td>0.0331</td><td>-</td></tr> <tr><td>8</td><td>0.0319</td><td>0.0319</td><td>-</td></tr> <tr><td>9</td><td>0.0266</td><td>0.0266</td><td>-</td></tr> <tr><td>10</td><td>0.0242</td><td>0.0242</td><td>-</td></tr> <tr><td>11</td><td>0.0310</td><td>0.0310</td><td>-</td></tr> <tr><td>12</td><td>0.0287</td><td>0.0287</td><td>-</td></tr> </tbody> </table>	Month	Average value (tCOD/m <sup>3</sup> )			2017		2018	(lower value)	Higher value	1	-	-	0.0256	2	-	-	0.0308	3	-	-	0.0283	4	-	-	0.0320	5	-	-	Plant shut down	6	-	-	Plant shut down	7	0.0325	0.0331	-	8	0.0319	0.0319	-	9	0.0266	0.0266	-	10	0.0242	0.0242	-	11	0.0310	0.0310	-	12	0.0287	0.0287	-
Month	Average value (tCOD/m <sup>3</sup> )																																																									
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Monitoring equipment	<table border="1"> <tr><td>Equipment Type</td><td>Spectrophotometer</td></tr> <tr><td>Manufacturer</td><td>HACH</td></tr> <tr><td>Model</td><td>DR3900</td></tr> <tr><td>Maximum permissible error</td><td>±1%</td></tr> <tr><td>Serial No.</td><td>1703661</td></tr> <tr><td>Calibration Frequency</td><td>Annually</td></tr> <tr><td>Date of latest calibration</td><td>26/07/2017</td></tr> <tr><td>Date of validity</td><td>25/07/2018</td></tr> <tr><td>Date of installation</td><td>28/05/2017 to present</td></tr> </table>	Equipment Type	Spectrophotometer	Manufacturer	HACH	Model	DR3900	Maximum permissible error	±1%	Serial No.	1703661	Calibration Frequency	Annually	Date of latest calibration	26/07/2017	Date of validity	25/07/2018	Date of installation	28/05/2017 to present																																							
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Date of validity	25/07/2018																																																									
Date of installation	28/05/2017 to present																																																									
Measuring/reading/recording frequency	The measurement was conducted onsite laboratory. The COD content was analysed by the close reflux method in compliance with the international standard. The major equipment involved with the analysis was a spectrophotometer – DR3900. The samples of wastewater were taken and analysed on a daily basis. Also, the analysis results were daily logged in the plant operation report.																																																									
Calculation method (if applicable)	n/a																																																									
QA/QC procedures	The calibration of relevant monitoring shall be conducted at least once a year. The monthly samples were collected and analysed by accredited laboratory using a similar or an equal standard in order to obtain the accuracy of the crosschecked results.																																																									
Purpose of data/parameter	Calculation of baseline emissions; the lower value is chose for the emission reduction calculation.																																																									
Additional comments	Since, the latest calibration record of this spectrophotometer was available on 26/07/2017, therefore, the calibration gap was identified during 01/07/2017 to 26/07/2017. The error identification between maximum permissible error specified in technical document and error found in the calibration report were compared. As a result, the maximum error of 1% indicated in the technical document is applied for emission reduction calculation during the calibration gap.																																																									

<b>Data/Parameter</b>	<b>COD<sub>eff,dig,m</sub></b>																																																									
Unit	tCOD/m <sup>3</sup>																																																									
Description	Average chemical oxygen demand in the effluent from the digester in month m																																																									
Measured/calculated/default	Measured																																																									
Source of data	Laboratory test (internal and external)																																																									
Value(s) of monitored parameter	<table border="1"> <thead> <tr> <th rowspan="3">Month</th><th colspan="3">Average value (tCOD/m<sup>3</sup>)</th></tr> <tr> <th colspan="2">2017</th><th rowspan="2">2018</th></tr> <tr> <th>Lower value</th><th>Higher value</th></tr> </thead> <tbody> <tr><td>1</td><td>-</td><td>-</td><td>0.0010</td></tr> <tr><td>2</td><td>-</td><td>-</td><td>0.0012</td></tr> <tr><td>3</td><td>-</td><td>-</td><td>0.0012</td></tr> <tr><td>4</td><td>-</td><td>-</td><td>0.0013</td></tr> <tr><td>5</td><td>-</td><td>-</td><td>Plant shut down</td></tr> <tr><td>6</td><td>-</td><td>-</td><td>Plant shut down</td></tr> <tr><td>7</td><td>0.0017</td><td>0.0018</td><td>-</td></tr> <tr><td>8</td><td>0.0014</td><td>0.0014</td><td>-</td></tr> <tr><td>9</td><td>0.0012</td><td>0.0012</td><td>-</td></tr> <tr><td>10</td><td>0.0010</td><td>0.0010</td><td>-</td></tr> <tr><td>11</td><td>0.0013</td><td>0.0013</td><td>-</td></tr> <tr><td>12</td><td>0.0011</td><td>0.0011</td><td>-</td></tr> </tbody> </table>	Month	Average value (tCOD/m <sup>3</sup> )			2017		2018	Lower value	Higher value	1	-	-	0.0010	2	-	-	0.0012	3	-	-	0.0012	4	-	-	0.0013	5	-	-	Plant shut down	6	-	-	Plant shut down	7	0.0017	0.0018	-	8	0.0014	0.0014	-	9	0.0012	0.0012	-	10	0.0010	0.0010	-	11	0.0013	0.0013	-	12	0.0011	0.0011	-
Month	Average value (tCOD/m <sup>3</sup> )																																																									
	2017		2018																																																							
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1	-	-	0.0010																																																							
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7	0.0017	0.0018	-																																																							
8	0.0014	0.0014	-																																																							
9	0.0012	0.0012	-																																																							
10	0.0010	0.0010	-																																																							
11	0.0013	0.0013	-																																																							
12	0.0011	0.0011	-																																																							
Monitoring equipment	Same as parameter "COD <sub>dig,m</sub> "																																																									
Measuring/reading/recording frequency	Same as parameter "COD <sub>dig,m</sub> "																																																									
Calculation method (if applicable)	n/a																																																									
QA/QC procedures	Same as parameter "COD <sub>dig,m</sub> "																																																									
Purpose of data/parameter	n/a																																																									
Additional comments	Same as parameter "COD <sub>dig,m</sub> "																																																									

<b>Data/Parameter</b>	<b>COD<sub>discharge,m</sub></b>
Unit	tCOD/m <sup>3</sup>
Description	Average chemical oxygen demand in the effluent discharged in month m
Measured/calculated/default	Measured
Source of data	Laboratory test (internal and external)

Value(s) of monitored parameter	<table><tr><th rowspan="3">Month</th><th colspan="3">Average value (tCOD/m<sup>3</sup>)</th></tr><tr><th colspan="2">2017</th><th rowspan="2">2018</th></tr><tr><th>Lower value</th><th>Higher value</th></tr><tr><td>1</td><td>-</td><td>-</td><td>0.00006</td></tr><tr><td>2</td><td>-</td><td>-</td><td>0.00006</td></tr><tr><td>3</td><td>-</td><td>-</td><td>0.00005</td></tr><tr><td>4</td><td>-</td><td>-</td><td>0.00004</td></tr><tr><td>5</td><td>-</td><td>-</td><td>Plant shut down</td></tr><tr><td>6</td><td>-</td><td>-</td><td>Plant shut down</td></tr><tr><td>7</td><td>0.00011</td><td>0.00012</td><td>-</td></tr><tr><td>8</td><td>0.00011</td><td>0.00011</td><td>-</td></tr><tr><td>9</td><td>0.00009</td><td>0.00009</td><td>-</td></tr><tr><td>10</td><td>0.00006</td><td>0.00006</td><td>-</td></tr><tr><td>11</td><td>0.00008</td><td>0.00008</td><td>-</td></tr><tr><td>12</td><td>0.00008</td><td>0.00008</td><td>-</td></tr></table>	Month	Average value (tCOD/m <sup>3</sup> )			2017		2018	Lower value	Higher value	1	-	-	0.00006	2	-	-	0.00006	3	-	-	0.00005	4	-	-	0.00004	5	-	-	Plant shut down	6	-	-	Plant shut down	7	0.00011	0.00012	-	8	0.00011	0.00011	-	9	0.00009	0.00009	-	10	0.00006	0.00006	-	11	0.00008	0.00008	-	12	0.00008	0.00008	-
	Month		Average value (tCOD/m <sup>3</sup> )																																																							
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Monitoring equipment	Same as parameter “COD <sub>dig,m</sub> ”																																																									
Measuring/reading/recording frequency	Same as parameter “COD <sub>dig,m</sub> ”																																																									
Calculation method (if applicable)	n/a																																																									
QA/QC procedures	Same as parameter “COD <sub>dig,m</sub> ”																																																									
Purpose of data/parameter	Calculation of leakage emission; The higher value is chose for the emission reduction calculation.																																																									
Additional comments	-																																																									

Data/Parameter	$F_{\text{biogas, y}} / V_{\text{t,db}} / F_{\text{CH}_4, \text{RG, m}} / Q_{\text{biogas, y}}$													
Unit	Nm <sup>3</sup> /yr													
Description	Total amount of biogas collected at the outlet of the digester tanks, Volumetric flow of the gaseous stream /(biogas) in minute													
Measured/calculated/default	Measured													
Source of data	Plant records													
Value(s) of monitored parameter	<table><tr><th rowspan="2">Monitoring period</th><th colspan="2">Total value (Nm<sup>3</sup>)</th></tr><tr><th>Lower</th><th>Higher</th></tr><tr><td>01/07/2017 – 31/12/2017</td><td>7,546,568</td><td>7,845,218</td></tr><tr><td>01/01/2018 – 30/06/2018</td><td>2,767,110</td><td>2,841,370</td></tr></table>			Monitoring period	Total value (Nm <sup>3</sup> )		Lower	Higher	01/07/2017 – 31/12/2017	7,546,568	7,845,218	01/01/2018 – 30/06/2018	2,767,110	2,841,370
Monitoring period	Total value (Nm <sup>3</sup> )													
	Lower	Higher												
01/07/2017 – 31/12/2017	7,546,568	7,845,218												
01/01/2018 – 30/06/2018	2,767,110	2,841,370												
Monitoring equipment	The detail of monitoring equipment is referred to parameter $F_{\text{biogasKILN, y}}$ and parameter $F_{\text{biogasFLARE, y}}$ as below.													
Measuring/reading/recording frequency	The biogas was monitored using continuous flow meters. The measurement has been taken on an hourly basis. The flow meter was integrated with online system to have real time data monitoring and control. The biogas flow meter displays output as normalized flow of biogas. The monitored data were recorded on logsheets as well as on digital storage device. The recorded values are aggregated annually for emission reduction calculation.													

Calculation method (if applicable)	The monitored value are based on the sum value of parameter $F_{\text{biogasKILN},y}$ and parameter $F_{\text{biogasFLARE},y}$ .
QA/QC procedures	The magnetic flow meter shall be calibrated periodically based on manufacturer's specification from a certified testing agency but at least once every 3 years.
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	-

<b>Data/Parameter</b>	<b><math>F_{\text{biogasKILN},y}</math></b>																				
Unit	Nm <sup>3</sup> /yr																				
Description	Volumetric flow of biogas to the boiler																				
Measured/calculated/default	Measured																				
Source of data	Plant records																				
Value(s) of monitored parameter	<table border="1"> <thead> <tr> <th>Monitoring period</th><th>Total value (Nm<sup>3</sup>)</th></tr> </thead> <tbody> <tr> <td>01/07/2017 – 31/12/2017</td><td>5,043,977</td></tr> <tr> <td>01/01/2018 – 30/06/2018</td><td>1,960,844</td></tr> </tbody> </table>	Monitoring period	Total value (Nm <sup>3</sup> )	01/07/2017 – 31/12/2017	5,043,977	01/01/2018 – 30/06/2018	1,960,844														
Monitoring period	Total value (Nm <sup>3</sup> )																				
01/07/2017 – 31/12/2017	5,043,977																				
01/01/2018 – 30/06/2018	1,960,844																				
Monitoring equipment	<table border="1"> <tbody> <tr><td>Tag</td><td>FT101G</td></tr> <tr><td>Equipment Type</td><td>Mass flow meter</td></tr> <tr><td>Manufacturer</td><td>Endress+Hauser</td></tr> <tr><td>Model</td><td>Proline t-mass I</td></tr> <tr><td>Maximum permissible error</td><td>±1%</td></tr> <tr><td>Serial No.</td><td>HA076802000</td></tr> <tr><td>Calibration Frequency</td><td>Once in three years</td></tr> <tr><td>Date of latest calibration</td><td>03/07/2015</td></tr> <tr><td>Date of validity</td><td>02/07/2018</td></tr> <tr><td>Installation date</td><td>COD to present</td></tr> </tbody> </table>	Tag	FT101G	Equipment Type	Mass flow meter	Manufacturer	Endress+Hauser	Model	Proline t-mass I	Maximum permissible error	±1%	Serial No.	HA076802000	Calibration Frequency	Once in three years	Date of latest calibration	03/07/2015	Date of validity	02/07/2018	Installation date	COD to present
Tag	FT101G																				
Equipment Type	Mass flow meter																				
Manufacturer	Endress+Hauser																				
Model	Proline t-mass I																				
Maximum permissible error	±1%																				
Serial No.	HA076802000																				
Calibration Frequency	Once in three years																				
Date of latest calibration	03/07/2015																				
Date of validity	02/07/2018																				
Installation date	COD to present																				
Measuring/reading/recording frequency	The biogas was monitored using continuous flow meter. The measurement has been taken on an hourly basis. The flow meter was integrated with online system to have real time data monitoring and control. The biogas flow meter displays output as normalized flow of biogas. The monitored data were recorded on log sheets as well as on digital storage device. The recorded values are aggregated annually for emission reduction calculation.																				
Calculation method (if applicable)	n/a																				
QA/QC procedures	As per the registered PDD, the magnetic flow meter shall be calibrated periodically based on manufacturer's specification from a certified testing agency but at least once every 3 years.																				
Purpose of data/parameter	Calculation of baseline emissions/project emissions																				
Additional comments	In this monitoring period, the calibration of monitoring equipment was conducted on time.																				

<b>Data/Parameter</b>	<b><math>F_{\text{biogasFLARE},y}</math></b>
Unit	Nm <sup>3</sup> /yr
Description	Volumetric flow of Biogas to flare

Measured/calculated/default	Measured																																								
Source of data	Plant records																																								
Value(s) of monitored parameter	<table border="1"> <thead> <tr> <th rowspan="2">Monitoring period</th><th colspan="2">Total value (Nm<sup>3</sup>)</th></tr> <tr> <th>Lower</th><th>Higher</th></tr> </thead> <tbody> <tr> <td>01/07/2017 – 31/12/2017</td><td>2,502,591</td><td>806,266</td></tr> <tr> <td>01/01/2018 – 30/06/2018</td><td>2,801,241</td><td>880,526</td></tr> </tbody> </table>	Monitoring period	Total value (Nm <sup>3</sup> )		Lower	Higher	01/07/2017 – 31/12/2017	2,502,591	806,266	01/01/2018 – 30/06/2018	2,801,241	880,526																													
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Monitoring equipment	<table border="1"> <thead> <tr> <th>Tag</th><th>FT105G (Open flare)</th></tr> </thead> <tbody> <tr><td>Equipment Type</td><td>Mass flow meter</td></tr> <tr><td>Manufacturer</td><td>Endress+Hauser</td></tr> <tr><td>Model</td><td>Proline t-mass I</td></tr> <tr><td>Maximum permissible error</td><td>±1%</td></tr> <tr><td>Serial No.</td><td>HA076902000 (New)</td></tr> <tr><td>Calibration Frequency</td><td>Once in three years</td></tr> <tr><td>Date of latest calibration</td><td>06/03/2018</td></tr> <tr><td>Date of validity</td><td>05/03/2021</td></tr> <tr><td>Installation date</td><td>11/06/2017 to present</td></tr> </tbody> </table> <table border="1"> <thead> <tr> <th>Tag</th><th>FT102G (Enclosed flare)</th></tr> </thead> <tbody> <tr><td>Equipment Type</td><td>Mass flow meter</td></tr> <tr><td>Manufacturer</td><td>Endress+Hauser</td></tr> <tr><td>Model</td><td>Proline t-mass I</td></tr> <tr><td>Maximum permissible error</td><td>±1%</td></tr> <tr><td>Serial No.</td><td>H7100A02000</td></tr> <tr><td>Calibration Frequency</td><td>Once in three years</td></tr> <tr><td>Date of latest calibration</td><td>06/03/2018</td></tr> <tr><td>Date of validity</td><td>05/03/2021</td></tr> <tr><td>Installation date</td><td>14/09/2016 to present</td></tr> </tbody> </table>	Tag	FT105G (Open flare)	Equipment Type	Mass flow meter	Manufacturer	Endress+Hauser	Model	Proline t-mass I	Maximum permissible error	±1%	Serial No.	HA076902000 (New)	Calibration Frequency	Once in three years	Date of latest calibration	06/03/2018	Date of validity	05/03/2021	Installation date	11/06/2017 to present	Tag	FT102G (Enclosed flare)	Equipment Type	Mass flow meter	Manufacturer	Endress+Hauser	Model	Proline t-mass I	Maximum permissible error	±1%	Serial No.	H7100A02000	Calibration Frequency	Once in three years	Date of latest calibration	06/03/2018	Date of validity	05/03/2021	Installation date	14/09/2016 to present
Tag	FT105G (Open flare)																																								
Equipment Type	Mass flow meter																																								
Manufacturer	Endress+Hauser																																								
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Installation date	14/09/2016 to present																																								
Measuring/reading/recording frequency	<p>The biogas was monitored using continuous flow meters. The measurement has been taken on an hourly basis. The flow meter was integrated with online system to have real time data monitoring and control. The biogas flow meter displays output as normalized flow of biogas. The monitored data were recorded on logsheets as well as on digital storage device. The recorded values are aggregated annually for emission reduction calculation. Two monitoring points involved with measurement of biogas sent enclosed flare system and open flare system.</p> <p>At the open flare system, the flow meter with S/N HA076902000 measured amount of biogas sent to this system while meter with S/N H7100A02000 measured amount of biogas sent to the enclosed system.</p>																																								
Calculation method (if applicable)	n/a																																								
QA/QC procedures	The magnetic flow meter was calibrated periodically based on manufacturer's specification from a certified testing agency but at least once every 3 years.																																								
Purpose of data/parameter	Calculation of project emissions																																								

Additional comments	<p>At the open flare system, the calibration report of the meter (S/N HA076902000) was available on 06/03/2018. Therefore, the calibration gap is identified during 01/07/2017 to 06/03/2018. The maximum error found between technical specification and calibration report of 6.38% is applied with project emission calculation.</p> <p>At the enclosed flare system, the calibration of flow meter S/N H7100A02000 was available on 06/03/2018. The calibration gap can be identified from 01/07/2017 to 06/03/2018. The maximum error found between technical specification and calibration report of 3.78% is applied with project emission calculation.</p>
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Data/Parameter	W <sub>CH4,biogas, y</sub> V <sub>i,t,db</sub>																													
Unit	kg CH <sub>4</sub> /m <sup>3</sup> , m <sup>3</sup> CH <sub>4</sub> / m <sup>3</sup> biogas																													
Description	Concentration of methane in the total biogas supply, Volumetric fraction of greenhouse gas I in the gaseous stream in a time interval t on a dry basis																													
Measured/calculated/ default	Measured																													
Source of data	Plant records																													
Value(s) of monitored parameter	<table><tr><th rowspan="2">Monitoring period</th><th colspan="2">%CH<sub>4</sub></th></tr><tr><th>Lower Value</th><th>Higher Value</th></tr><tr><td>01/07/2017 – 31/12/2017</td><td>70%</td><td>72%</td></tr><tr><td>01/01/2018 – 30/06/2018</td><td>72%</td><td>72%</td></tr></table>			Monitoring period	%CH <sub>4</sub>		Lower Value	Higher Value	01/07/2017 – 31/12/2017	70%	72%	01/01/2018 – 30/06/2018	72%	72%																
Monitoring period	%CH <sub>4</sub>																													
	Lower Value	Higher Value																												
01/07/2017 – 31/12/2017	70%	72%																												
01/01/2018 – 30/06/2018	72%	72%																												
Monitoring equipment	<table><tr><td>Equipment Type</td><td colspan="2">Gas Analyzer</td></tr><tr><td>Manufacturer</td><td colspan="2">Fuji</td></tr><tr><td>Model</td><td colspan="2">ZKJ</td></tr><tr><td>Maximum permissible error</td><td colspan="2">±1%</td></tr><tr><td>Serial No.</td><td colspan="2">N6A0091 (new)</td></tr><tr><td>Calibration Frequency</td><td colspan="2">Once in three year</td></tr><tr><td>Date of latest calibration</td><td colspan="2">10/12/2017</td></tr><tr><td>Date of validity</td><td colspan="2">09/12/2020</td></tr><tr><td>Date of installation</td><td colspan="2">27/05/2017 to present</td></tr></table>			Equipment Type	Gas Analyzer		Manufacturer	Fuji		Model	ZKJ		Maximum permissible error	±1%		Serial No.	N6A0091 (new)		Calibration Frequency	Once in three year		Date of latest calibration	10/12/2017		Date of validity	09/12/2020		Date of installation	27/05/2017 to present	
Equipment Type	Gas Analyzer																													
Manufacturer	Fuji																													
Model	ZKJ																													
Maximum permissible error	±1%																													
Serial No.	N6A0091 (new)																													
Calibration Frequency	Once in three year																													
Date of latest calibration	10/12/2017																													
Date of validity	09/12/2020																													
Date of installation	27/05/2017 to present																													
Measuring/reading/recording frequency	The methane percentage was measured using continuous gas analyser. The monitored data were recorded on logsheets as well as on digital storage device. The average monitoring values were applied for emission reduction calculation.																													
Calculation method (if applicable)	n/a																													
QA/QC procedures	Accuracy of equipment is based on manufacturer standards and regular calibration is provided by manufacturer or approved company (frequency of calibration as recommended by manufacturer).																													
Purpose of data/parameter	Calculation of baseline and project emissions.																													
Additional comments	<p>As per the calibration report of gas analyser with S/N N6A0091, the calibration gap was found during 01/07/2017 to 10/12/2017. The maximum error of 2% shown in the calibration report of the existing gas analyser was applied with monitoring data during the gap in 2017.</p> <p>As a result of error application, the conservative value is applied for calculation of emission reduction.</p>																													



Data/Parameter	Other flare operation parameters – Flame detector																												
Unit	On/Off or numeric value indicating On/Off																												
Description	Detection unit																												
Measured/calculated/default	Measured																												
Source of data	Plant records																												
Value(s) of monitored parameter	<table border="1"> <thead> <tr> <th>Monitoring period</th><th>Value</th></tr> </thead> <tbody> <tr> <td>01/07/2017 – 31/12/2017</td><td>No data record</td></tr> <tr> <td>01/01/2018 – 30/06/2018</td><td>No data record</td></tr> </tbody> </table>	Monitoring period	Value	01/07/2017 – 31/12/2017	No data record	01/01/2018 – 30/06/2018	No data record																						
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Monitoring equipment	<table border="1"> <thead> <tr> <th colspan="2">At open flare system</th></tr> </thead> <tbody> <tr> <td>Equipment Type</td><td>UV Flame sensor/check</td></tr> <tr> <td>Manufacturer</td><td>Siemen/Varec</td></tr> <tr> <td>Model</td><td>316 SS - 5200</td></tr> <tr> <td>Tags:</td><td>FC (A) – CV104G FC (B) – CV105G FC (C) – CV106G</td></tr> <tr> <td>Serial No.</td><td>Not specified* Three sets of detectors installed</td></tr> <tr> <td>Installation date:</td><td>COD to present</td></tr> </tbody> </table> <p>Note: Three units of open flares are installed at the project site. A flame detector is installed at each unit of open flare.</p> <table border="1"> <thead> <tr> <th colspan="2">At enclosed flare system</th></tr> </thead> <tbody> <tr> <td>Equipment Type</td><td>UV or Flame ionization detector</td></tr> <tr> <td>Manufacturer</td><td>Napatr Service</td></tr> <tr> <td>Model</td><td>Not specified*</td></tr> <tr> <td>Tags:</td><td>FD (I) – CV102G FD (II) – CV103G</td></tr> <tr> <td>Serial No.</td><td>Not specified* Two sets of detectors installed</td></tr> <tr> <td>Installation date:</td><td>14/09/2016 to present</td></tr> </tbody> </table> <p>Note: Two units of enclosed flares are installed at the project site. A flame detector is installed at each unit of enclosed flare.</p>	At open flare system		Equipment Type	UV Flame sensor/check	Manufacturer	Siemen/Varec	Model	316 SS - 5200	Tags:	FC (A) – CV104G FC (B) – CV105G FC (C) – CV106G	Serial No.	Not specified* Three sets of detectors installed	Installation date:	COD to present	At enclosed flare system		Equipment Type	UV or Flame ionization detector	Manufacturer	Napatr Service	Model	Not specified*	Tags:	FD (I) – CV102G FD (II) – CV103G	Serial No.	Not specified* Two sets of detectors installed	Installation date:	14/09/2016 to present
At open flare system																													
Equipment Type	UV Flame sensor/check																												
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Equipment Type	UV or Flame ionization detector																												
Manufacturer	Napatr Service																												
Model	Not specified*																												
Tags:	FD (I) – CV102G FD (II) – CV103G																												
Serial No.	Not specified* Two sets of detectors installed																												
Installation date:	14/09/2016 to present																												
Measuring/reading/recording frequency	The sensor was installed and linked to computer display to show status of the flame. Continuously, it displayed on/off status on the computer display. This was accompanied by a record of the time during operation of flare.																												
Calculation method (if applicable)	n/a																												
QA/QC procedures	The calibration shall be conducted as per technical or manufacturers specification.																												
Purpose of data/parameter	Calculation of project emission																												
Additional comments	This parameter is used for determination of the flare efficiency of open flare and enclosed flare. Due to the monitored data and calibration report was not available during this monitoring period. Therefore, the value of flare efficiency is assumed as zero % for calculating the project emission. This is conservative for ER calculation.																												

Data/Parameter	EC <sub>PJ,y</sub>
Unit	MWh/yr

Description	Amount of electricity in the year y that is consumed at the project site for the project activity																				
Measured/calculated/default	Measured																				
Source of data	Plant records																				
Value(s) of monitored parameter	<table border="1"> <thead> <tr> <th>Monitoring period</th><th>MWh</th></tr> </thead> <tbody> <tr> <td>01/07/2017 – 31/12/2017</td><td>5,386.92</td></tr> <tr> <td>01/01/2018 – 30/06/2018</td><td>3,751.74</td></tr> </tbody> </table>	Monitoring period	MWh	01/07/2017 – 31/12/2017	5,386.92	01/01/2018 – 30/06/2018	3,751.74														
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Monitoring equipment	<table border="1"> <tr> <td>Tag</td><td>MDB</td></tr> <tr> <td>Equipment Type</td><td>Power meter</td></tr> <tr> <td>Manufacturer</td><td>AMPTRON</td></tr> <tr> <td>Model</td><td>Ai205 Pro</td></tr> <tr> <td>Maximum permissible error</td><td>±0.5%</td></tr> <tr> <td>Serial No.</td><td>AT12051374</td></tr> <tr> <td>Calibration Frequency</td><td>Once a year</td></tr> <tr> <td>Date of latest calibration</td><td>30/12/2016</td></tr> <tr> <td>Date of validity</td><td>29/12/2017</td></tr> <tr> <td>Installation date</td><td>COD to present</td></tr> </table>	Tag	MDB	Equipment Type	Power meter	Manufacturer	AMPTRON	Model	Ai205 Pro	Maximum permissible error	±0.5%	Serial No.	AT12051374	Calibration Frequency	Once a year	Date of latest calibration	30/12/2016	Date of validity	29/12/2017	Installation date	COD to present
Tag	MDB																				
Equipment Type	Power meter																				
Manufacturer	AMPTRON																				
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Maximum permissible error	±0.5%																				
Serial No.	AT12051374																				
Calibration Frequency	Once a year																				
Date of latest calibration	30/12/2016																				
Date of validity	29/12/2017																				
Installation date	COD to present																				
Measuring/reading/recording frequency	The electricity consumption in the project was monitored by using power meter. The daily measurement was continuously conducted. The monitored data were recorded on log sheets as well as on digital storage device.																				
Calculation method (if applicable)	n/a																				
QA/QC procedures	The electricity meter was calibrated as per appropriate industrial standards or manufacture's recommendation.																				
Purpose of data/parameter	Calculation of project emission																				
Additional comments	-																				

<b>Data/Parameter</b>	<b>S<sub>LA,y</sub></b>
Unit	m <sup>3</sup> /month
Description	Quantity of sludge applied to land
Measured/calculated/default	Measured
Source of data	Plant records

Value(s) of monitored parameter	<table border="1"> <thead> <tr> <th data-bbox="699 219 858 248">Month</th><th colspan="2" data-bbox="858 219 1273 248">Total value (ton)</th></tr> <tr> <th></th><th data-bbox="858 248 1066 277">2017</th><th data-bbox="1066 248 1273 277">2018</th></tr> </thead> <tbody> <tr><td>1</td><td>-</td><td>1,051.24</td></tr> <tr><td>2</td><td>-</td><td>897.18</td></tr> <tr><td>3</td><td>-</td><td>1,255.64</td></tr> <tr><td>4</td><td>-</td><td>624.44</td></tr> <tr><td>5</td><td>-</td><td>278.99</td></tr> <tr><td>6</td><td>-</td><td>229.85</td></tr> <tr><td>7</td><td>1,734.99</td><td>-</td></tr> <tr><td>8</td><td>1,489.32</td><td>-</td></tr> <tr><td>9</td><td>1,568.92</td><td>-</td></tr> <tr><td>10</td><td>4,280.10</td><td>-</td></tr> <tr><td>11</td><td>2,236.50</td><td>-</td></tr> <tr><td>12</td><td>1,517.27</td><td>-</td></tr> </tbody> </table>	Month	Total value (ton)			2017	2018	1	-	1,051.24	2	-	897.18	3	-	1,255.64	4	-	624.44	5	-	278.99	6	-	229.85	7	1,734.99	-	8	1,489.32	-	9	1,568.92	-	10	4,280.10	-	11	2,236.50	-	12	1,517.27	-
Month	Total value (ton)																																										
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Monitoring equipment	<table border="1"> <tr><td>Equipment Type</td><td>Weighbridge</td></tr> <tr><td>Manufacturer</td><td>FILTEC</td></tr> <tr><td>Model</td><td>SK-11</td></tr> <tr><td>Serial No.</td><td>000172</td></tr> <tr><td>Maximum permissible error</td><td>±0.2%</td></tr> <tr><td>Calibration Frequency</td><td>Two years</td></tr> <tr><td>Date of previous calibration</td><td>03/04/2015</td></tr> <tr><td>Date of latest calibration</td><td>14/03/2017</td></tr> <tr><td>Date of validity</td><td>13/03/2019</td></tr> </table> <table border="1"> <tr><td>Equipment Type</td><td>Weighbridge</td></tr> <tr><td>Manufacturer</td><td>FILTEC</td></tr> <tr><td>Model</td><td>SK-11</td></tr> <tr><td>Serial No.</td><td>000176</td></tr> <tr><td>Maximum permissible error</td><td>±0.2%</td></tr> <tr><td>Calibration Frequency</td><td>Two years</td></tr> <tr><td>Date of previous calibration</td><td>03/04/2015</td></tr> <tr><td>Date of latest calibration</td><td>14/03/2017</td></tr> <tr><td>Date of validity</td><td>13/03/2019</td></tr> </table>	Equipment Type	Weighbridge	Manufacturer	FILTEC	Model	SK-11	Serial No.	000172	Maximum permissible error	±0.2%	Calibration Frequency	Two years	Date of previous calibration	03/04/2015	Date of latest calibration	14/03/2017	Date of validity	13/03/2019	Equipment Type	Weighbridge	Manufacturer	FILTEC	Model	SK-11	Serial No.	000176	Maximum permissible error	±0.2%	Calibration Frequency	Two years	Date of previous calibration	03/04/2015	Date of latest calibration	14/03/2017	Date of validity	13/03/2019						
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Date of latest calibration	14/03/2017																																										
Date of validity	13/03/2019																																										
Measuring/reading/recording frequency	The sludge generated by the digester and secondary treatment system was pumped to a belt press. Then a conveyor transferred them to a storage area where the sludge transported for further utilization. The measurement of sludge was conducted by weighbridge. The monitoring data was recorded on the log-sheet and aggregated monthly.																																										
Calculation method (if applicable)	n/a																																										
QA/QC procedures	The equipment calibration shall be conducted as per technical or manufacturers specification.																																										
Purpose of data/parameter	Calculation of project emission																																										
Additional comments	The sludge was collected and stored for some period of time. This monitoring was to ensure that the anaerobic condition was not developed in the storage facility. The sludge was distributed to farmers or collectors for fertilizer utilization in the eucalyptus plantation area or soil improvement under aerobic condition.																																										

Data/Parameter	T <sub>2,m</sub>																																									
Unit	K																																									
Description	Average temperature at the project site in month m																																									
Measured/calculated/default	Measured																																									
Source of data	Thai Meteorological Department. Reference link: <a href="http://www.tmd.go.th/programs/uploads/yearlySummary/annual2015_e.pdf">http://www.tmd.go.th/programs/uploads/yearlySummary/annual2015_e.pdf</a>																																									
Value(s) of monitored parameter	<table><tr><th rowspan="2">Month</th><th colspan="2">Temperature (K)</th></tr><tr><th>2017</th><th>2018</th></tr><tr><td>1</td><td>-</td><td>300.85</td></tr><tr><td>2</td><td>-</td><td>300.65</td></tr><tr><td>3</td><td>-</td><td>302.45</td></tr><tr><td>4</td><td>-</td><td>302.55</td></tr><tr><td>5</td><td>-</td><td>302.85</td></tr><tr><td>6</td><td>-</td><td>302.45</td></tr><tr><td>7</td><td>301.45</td><td>-</td></tr><tr><td>8</td><td>302.15</td><td>-</td></tr><tr><td>9</td><td>302.65</td><td>-</td></tr><tr><td>10</td><td>301.85</td><td>-</td></tr><tr><td>11</td><td>301.25</td><td>-</td></tr><tr><td>12</td><td>299.85</td><td>-</td></tr></table>	Month	Temperature (K)		2017	2018	1	-	300.85	2	-	300.65	3	-	302.45	4	-	302.55	5	-	302.85	6	-	302.45	7	301.45	-	8	302.15	-	9	302.65	-	10	301.85	-	11	301.25	-	12	299.85	-
Month	Temperature (K)																																									
	2017	2018																																								
1	-	300.85																																								
2	-	300.65																																								
3	-	302.45																																								
4	-	302.55																																								
5	-	302.85																																								
6	-	302.45																																								
7	301.45	-																																								
8	302.15	-																																								
9	302.65	-																																								
10	301.85	-																																								
11	301.25	-																																								
12	299.85	-																																								
Monitoring equipment	The monitoring data were based on monthly information by national or regional weather statistics during this monitoring period.																																									
Measuring/reading/recording frequency	Monthly measurement.																																									
Calculation method (if applicable)	n/a																																									
QA/QC procedures	Data was obtained from the regional weather department for eastern region where the project activity is located.																																									
Purpose of data/parameter	Calculation of baseline emission																																									
Additional comments	Applicable for the methane conversion factor method.																																									

Data/Parameter	T <sub>flare</sub> , T <sub>EG,m</sub>		
Unit	°C		
Description	Temperature in the exhaust gas in the flare		
Measured/calculated/default	Measured		
Source of data	Plant records		
Value(s) of monitored parameter	Monitoring period	T <sub>flare,m</sub> (open flare)	T <sub>EG,m</sub> (enclosed flare)
		Value (°C)	Value (°C)
	01/07/2017 – 31/12/2017	No data record	No data record
	01/01/2018 – 30/06/2018	No data record	No data record

Monitoring equipment	Equipment Type	Thermocouple Type K
	Manufacturer	Varec Biogas
	Model	316 SS
	Maximum permissible error	±0.75%
	Tags:	Thermo (A) – CV104G Thermo (B) – CV105G Thermo (C) – CV106G
	Serial No.	Not specified* Three sets of thermocouple installed
	Installation date:	Since commercial operation date (COD) to present
	Note: Three units of open flares are installed at the project site. A thermocouple type K is installed at each unit of open flare.	
	Equipment Type	Thermocouple
	Manufacturer	Napatr
Model	Type N	
Maximum permissible error	±0.75%	
Serial No.	Not specified* Two sets of thermocouple installed	
Tags:	Thermo (I) - CV102G Thermo (II) - CV103G	
Installation date	14/09/2017 to present	
Note: Two units of enclosed flares are installed. A thermocouple is installed at each unit of enclosed flare.		
Measuring/reading/recording frequency	Continuously measurement of temperature of the exhaust gas stream in the flare was carried out by thermocouple. A temperature above 200 °C indicates that a significant amount of biogas was burnt and that the flare was under operation.	
Calculation method (if applicable)	n/a	
QA/QC procedures	The calibration shall be conducted as per technical or manufacturers specification.	
Purpose of data/parameter	Calculation of project emission	
Additional comments	This parameter is used for determination of the flare efficiency of open flare and enclosed flare. Due to the monitored data as well as calibration report were not available during this monitoring period. Therefore, the value of flare efficiency is assumed as zero % for calculating the project emission. This is conservative.	

Data/Parameter	Flame <sub>m</sub>						
Unit	Flame on or Flame off						
Description	Flame detection of flare in the minute m						
Measured/calculated/default	Measured						
Source of data	Plant records						
Value(s) of monitored parameter	<table border="1"> <thead> <tr> <th>Monitoring period</th><th>Value</th></tr> </thead> <tbody> <tr> <td>01/07/2017 – 31/12/2017</td><td>No data record</td></tr> <tr> <td>01/01/2018 – 30/06/2018</td><td>No data record</td></tr> </tbody> </table>	Monitoring period	Value	01/07/2017 – 31/12/2017	No data record	01/01/2018 – 30/06/2018	No data record
Monitoring period	Value						
01/07/2017 – 31/12/2017	No data record						
01/01/2018 – 30/06/2018	No data record						

Monitoring equipment	<b>At open flare system</b>	
	Equipment Type	UV Flame sensor/check
	Manufacturer	Siemen/Varec
	Model	316 SS - 5200
	Tags:	FC (A) – CV104G FC (B) – CV105G FC (C) – CV106G
	Serial No.	Not specified* Three sets of detectors installed
	Installation date:	COD to present
	Note: Three units of open flares are installed at the project site. A flame detector is installed at each unit of open flare.	
	<b>At enclosed flare system</b>	
	Equipment Type	UV or Flame ionization detector
Manufacturer	Napatr Service	
Model	Not specified*	
Tags:	FD (I) – CV102G FD (II) – CV103G	
Serial No.	Not specified* Two sets of detectors installed	
Installation date:	14/09/2016 to present	
Note: Two units of enclosed flares are installed at the project site. A flame detector is installed at each unit of enclosed flare.		
Measuring/reading/recording frequency	Measure using a fixed installation optical flame detector: Ultra Violet detector. The flame detector shall be recorded as a minute during the flame was on, otherwise recorded as a minute that the flame was off.	
Calculation method (if applicable)	n/a	
QA/QC procedures	The calibration shall be maintained and calibrated as per technical or manufacturers specification.	
Purpose of data/parameter	Calculation of project emission	
Additional comments	This parameter is used for determination of the flare efficiency of open flare and enclosed flare. Due to the monitored data and calibration report was not available during this monitoring period. Therefore, the value of flare efficiency is assumed as zero % for calculating the project emission. This is conservative for ER calculation.	

Data/Parameter	Maintenance <sub>y</sub>
Unit	Calendar dates
Description	Maintenance events completed in year y
Measured/calculated/default	Measured
Source of data	Plant records

Value(s) of monitored parameter	<table border="1"> <tr> <th colspan="2">Open Flare</th></tr> <tr> <td>05/07/2017</td><td>Cleaned flame arrestor C</td></tr> <tr> <td>30/01/2018</td><td>Cleaned flame arrestor B</td></tr> <tr> <td>06/03/2018</td><td>Calibrated FT105G</td></tr> <tr> <th colspan="2">Enclosed Flare</th></tr> <tr> <td>01/05/2017</td><td>Cleaned flame arrestor</td></tr> <tr> <td>25/09/2017</td><td>Cleaned flame arrestor</td></tr> </table>	Open Flare		05/07/2017	Cleaned flame arrestor C	30/01/2018	Cleaned flame arrestor B	06/03/2018	Calibrated FT105G	Enclosed Flare		01/05/2017	Cleaned flame arrestor	25/09/2017	Cleaned flame arrestor
Open Flare															
05/07/2017	Cleaned flame arrestor C														
30/01/2018	Cleaned flame arrestor B														
06/03/2018	Calibrated FT105G														
Enclosed Flare															
01/05/2017	Cleaned flame arrestor														
25/09/2017	Cleaned flame arrestor														
Monitoring equipment	n/a														
Measuring/reading/recording frequency	Record the date that maintenance events were completed in year y. Records of maintenance logs must include all aspects of the maintenance including the details of the person (s) undertaking the work, parts replaced, or needing to be replaced, source of replacement parts, serial numbers and calibration certificates. The monitoring frequency shall be done annually.														
Calculation method (if applicable)	n/a														
QA/QC procedures	Records must be kept in a maintenance log for two years beyond the life of flare.														
Purpose of data/parameter	Calculation of project emission														
Additional comments	As per the flaring tool, the option A is selected to determine flare efficiency of an enclosed flare. Hence, this parameter is not required for emission reduction calculation. However, this parameter was recorded as per the monitoring plan in the registered PDD.														

### D.3. Implementation of sampling plan

This section is not applicable.

## SECTION E. Calculation of emission reductions or net anthropogenic removals

### E.1. Calculation of baseline emissions or baseline net removals

The proposed project activity involves the installation of a new anaerobic digester system for the treatment of wastewater. In comply with ACM0014, the baseline emissions are determined as following equations;

Baseline emissions are calculated using the following formula:

$$BE_y = BE_{CH_4,y} + BE_{EL,y} + BE_{HG,y} \quad (1)$$

Where:

- $BE_y$  = Baseline emissions in year y ( $tCO_2/yr$ )
- $BE_{CH_4,y}$  = Methane emissions from anaerobic treatment of the wastewater in open lagoons (Scenario 1) ( $tCO_2/yr$ )
- $BE_{EL,y}$  =  $CO_2$  emissions associated with electricity generation that is displaced by the project activity in year y ( $tCO_2/yr$ )

$BE_{HG,y}$  = CO<sub>2</sub> emissions associated with fossil fuel combustion for heating equipment that is displaced by the project in year  $y$  (tCO<sub>2</sub>/yr)

Baseline emissions are calculated in three steps, as follows:

*Step 1:* Calculation of baseline emissions from anaerobic treatment of the wastewater;

*Step 2:* Calculation of baseline emissions from generation and consumption of electricity;

*Step 3:* Calculation of baseline emissions from heat generation.

### ***Step 1: Calculation of baseline emissions from anaerobic treatment of the wastewater***

The methodology proposes to use the minimum value between the methane produced after the implementation of the project activity and methane conversion factor method for the estimation of methane emissions from open lagoons in case of the wastewater lagoons.

$$BE_{CH_4} = \min \{Q_{CH_4,y} ; BE_{CH_4,MCF,y}\} \quad (2)$$

#### Methane produced

Projects proponent shall use Step 1 "Determination of the quantity of methane produced in the digester ( $Q_{CH_4,y}$ )" of the latest version of the tool "Project and leakage emissions from anaerobic digesters" to determine the amount of methane produced after the implementation of the project activity ( $Q_{CH_4,y}$ ) is used. This is discussed in the section below.

#### Methane conversion factor

The baseline methane emissions from anaerobic treatment of the wastewater in open lagoons (Scenario 1) is estimated based on the chemical oxygen demand (COD) of the wastewater that would enter the lagoon in the absence of the project activity ( $COD_{BL,y}$ ), the maximum methane producing capacity ( $B_o$ ) and a methane conversion factor ( $MCF_{BL,y}$ ) which expresses the proportion of the wastewater that would decay to methane, as follows:

$$BE_{CH_4,MCF,y} = GWP_{CH_4} * MCF_{BL,y} * B_o * COD_{BL,y} \quad (3)$$

Where:

$BE_{CH_4,MCF,y}$  = Methane emissions from anaerobic treatment of the wastewater in open lagoons (Scenario 1) (tCO<sub>2</sub>/yr)

$GWP_{CH_4}$  = Global Warming Potential of methane valid for the commitment period (tCO<sub>2</sub>/tCH<sub>4</sub>)

$B_o$  = Maximum methane producing capacity, expressing the maximum amount of CH<sub>4</sub> that can be produced from a given quantity of chemical oxygen demand (tCH<sub>4</sub>/tCOD)

$MCF_{BL,y}$  = Average baseline methane conversion factor (fraction) in year  $y$ , representing the fraction of ( $COD_{PJ,y} \times B_o$ ) that would be degraded to CH<sub>4</sub> in the absence of the project activity

$COD_{BL,y}$  = Quantity of chemical oxygen demand that would be treated in open lagoons (Scenario 1) in the absence of the project activity in year  $y$  (tCOD/yr)



Determination of  $COD_{BL,y}$ 

In the absence of the project activity, wastewater would be treated to the open lagoon system. Therefore the baseline COD treated in open lagoons is equal to COD treated under the project activity minus any effluent COD that would have flowed from the outlet of the lagoons. The effluent COD in the baseline is accounted for through the use of an effluent adjustment factor as follows;

$$COD_{BL,y} = \rho * (1 - (COD_{out,x} / COD_{in,x})) * COD_{PJ,y} \quad (4)$$

Where:

- $COD_{BL,y}$  = Quantity of chemical oxygen demand that would be treated in open lagoons (Scenario 1) in the absence of the project activity in year  $y$  (t COD/yr)
- $COD_{PJ,y}$  = Quantity of chemical oxygen demand that is treated in the anaerobic digester or under clearly aerobic conditions in the project activity in year  $y$  (t COD/yr)
- $COD_{out,x}$  = COD of the effluent in the period  $x$  (t COD)
- $COD_{in,x}$  = COD directed to the open lagoons (Scenario 1) in the period  $x$  (t COD)
- $x$  = Representative historical reference period
- $\rho$  = Discount factor for historical information

$COD_{PJ,y}$  is determined as follows:

$$COD_{PJ,y} = \sum F_{PJ,dig,m} * COD_{dig,m} \quad (5)$$

Where:

- $COD_{PJ,y}$  = Quantity of chemical oxygen demand that is treated in the anaerobic digester in the project activity in year  $y$  (t COD/yr)
- $F_{PJ,dig,m}$  = Quantity of wastewater that is treated in the anaerobic digester in the project activity in month  $m$  (m<sup>3</sup>/month)
- $COD_{dig,m}$  = Chemical oxygen demand in the wastewater that is treated in the anaerobic digester in the project activity in month  $m$  (t COD / m<sup>3</sup>)
- $m$  = Months of year  $y$  of the crediting period

Determination of  $MCF_{BL,y}$ 

The quantity of methane generated from COD disposed to the open lagoon (Scenario 1) depends mainly on the temperature and the depth of the lagoon. Accordingly, the methane conversion factor is calculated based on a factor  $f_d$ , expressing the influence of the depth of the lagoon on methane generation, and a factor  $f_{T,y}$  expressing the influence of the temperature on the methane generation. In addition, a conservativeness factor of 0.89 is applied to account for the considerable uncertainty associated with this approach.  $MCF_{BL,y}$  is calculated as follows:

$$MCF_{BL,y} = f_d * f_{T,y} * 0.89 \quad (6)$$

Where:

- $MCF_{BL,y}$  = Average baseline methane conversion factor (fraction) in year  $y$ , representing the fraction of ( $COD_{PJ,y} \times B_o$ ) that would be degraded to CH<sub>4</sub> in the absence of the project activity
- $f_d$  = Factor expressing the influence of the depth of the lagoon on methane generation
- $f_{T,y}$  = Factor expressing the influence of the temperature on the methane generation in

0.89 = year  $y$   
 Conservativeness factor

### Determination of $f_d$

$f_d$  represents the influence of the average depth of the lagoons on methane generation.

$$f_d = \begin{cases} 0; & \text{if } D < 1 \text{ m} \\ 0.5; & \text{if } 1\text{m} \leq D < 2\text{m} \\ 0.7; & \text{if } D \geq 2\text{m} \end{cases}$$

Where:

$f_d$  = Factor expressing the influence of the depth of the lagoons on methane generation  
 $D$  = Average depth of the lagoons (m)

As per the registered PDD, the depth of lagoon is 6 m. Therefore, the value of 0.7 is chosen for  $f_d$ .

### Determination of $f_{T,y}$

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

$$\text{COD}_{\text{available},m} = \text{COD}_{\text{BL},m} + (1-f_{T,m-1}) * \text{COD}_{\text{available},m-1} \quad (7)$$

Where:

$\text{COD}_{\text{available},m}$  = Quantity of chemical oxygen demand available for degradation in the open lagoon in month  $m$  (t COD/month)  
 $\text{COD}_{\text{BL},m}$  = Quantity of chemical oxygen demand that would be treated in open lagoons (Scenario 1) in the absence of the project activity in month  $m$  (t COD/month)  
 $f_{T,m-1}$  = Factor expressing the influence of the temperature on the methane generation in previous month ( $m-1$ )  
 $m$  = Months of year  $y$  of the crediting period  
 $T$  = Temperature of the lagoon in the month (deg K)  
 $\text{COD}_{\text{available}, m-1}$  = Quantity of chemical oxygen demand that may have remained in the lagoon from previous month  $m-1$  (tCOD/month)

$$\text{COD}_{\text{BL},m} = (1 - (\text{COD}_{\text{out},x} / \text{COD}_{\text{in},x})) * \text{COD}_{\text{PJ},m} \quad (8)$$

Where:

- $\text{COD}_{\text{out},x}$  = COD of the effluent in the period  $x$  (t COD)  
 $\text{COD}_{\text{in},x}$  = COD directed to the open lagoons (Scenario 1) in the period  $x$  (t COD)  
 $\text{COD}_{\text{PJ},m}$  = Quantity of chemical oxygen demand that is treated in the anaerobic digester or in the project activity in month  $m$  (t COD/month)  
 $x$  = Representative historical reference period

and

$$\text{COD}_{\text{PJ},m} = F_{\text{PJ,dig},m} * \text{COD}_{\text{dig},m} \quad (9)$$

Where:

- $\text{COD}_{\text{PJ},m}$  = Quantity of chemical oxygen demand that is treated in the anaerobic digester or in the project activity in month  $m$  (t COD/month)  
 $F_{\text{PJ,dig},m}$  = Quantity of wastewater that is treated in the anaerobic digester or under clearly aerobic conditions in the project activity in month  $m$  (m<sup>3</sup>/month)  
 $\text{COD}_{\text{dig},m}$  = Chemical oxygen demand in the wastewater that is treated in the anaerobic digester in the project activity in month  $m$  (t COD/m<sup>3</sup>)

The carry-over calculations are limited to a maximum of one year. In case the residence time in the open lagoon is less than one year. The accumulation of organic matter restarts with the next inflow and the COD available from the previous month should be set to zero.

In the case of project activities implement in Greenfield facilities, where the baseline is a new to be built anaerobic lagoon, use the residence time of organic matter according to the design features of the lagoon that was identified as the baseline in Step 1 of the section "Procedure for the identification of the most plausible baseline scenario".

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

$$f_{T,m} = \begin{cases} 0 & \text{if } T_{2,m} < 278K \\ e^{\left(\frac{E \times (T_{2,m} - T_1)}{R \times T_1 \times T_{2,m}}\right)} & \text{if } 278K \leq T_{2,m} \leq 302.5K \\ 0.95 & \text{if } T_{2,m} > 302.5K \end{cases} \quad (10)$$

Where:

- $f_{T,m}$  = Factor expressing the influence of the temperature on the methane generation in month  $m$   
 $E$  = Activation energy constant (15,175 cal/mol)  
 $T_{2,m}$  = Average temperature at the project site in month  $m$  (K)  
 $T_1$  = 303.16 K (273.16 K + 30 K)  
 $R$  = Ideal gas constant (1.987 cal/K mol)  
 $m$  = Months of year  $y$  of the crediting period

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

The annual value  $f_{T,y}$  is calculated as follows:

$$f_{T,y} = \frac{\sum_{m=1}^{12} f_{T,m} \times COD_{available,m}}{\sum_{m=1}^{12} COD_{BL,m}} \quad (11)$$

Where:

- $f_{T,y}$  = Factor expressing the influence of the temperature on the methane generation in year  $y$
- $f_{T,m}$  = Factor expressing the influence of the temperature on the methane generation in month  $m$
- $COD_{available,m}$  = Quantity of chemical oxygen demand available for degradation in the open lagoon in month  $m$  (t COD/month)
- $COD_{BL,m}$  = Quantity of chemical oxygen demand that would be treated in open lagoons (Scenario 1) in the absence of the project activity in month  $m$  (t COD/month)
- $m$  = Months of year  $y$  of the crediting period

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

As per the registered PDD, the project participant may neglect one or both emission sources. Since there is no electricity generation in the project activity and for simplification and conservativeness the electricity part is neglected for this proposed project activity.

### **Step 3: Baseline emissions from the generation of heat**

The limekiln that utilizes the biogas of the project activity is not included into the project boundary. Hence, baseline emissions from the generation of heat are not claimed. This is a conservative approach.

**Table of calculation of baseline emissions**

<b>Baseline emissions</b>		<b>2017</b>	<b>2018</b>
		<b>01/07 to 31/12</b>	<b>01/01 to 30/06</b>
$BE_{Q, CH_4}$	$tCO_2$	94,267	35,878
$BE_{CH_4, MCF, y}$	$tCO_2$	120,296	59,246
$BE_{CH_4}$	$tCO_2$	94,267	35,878
$BE_y$ (round down)	$tCO_2$	94,267	35,877

## E.2. Calculation of project emissions or actual net removals

Emissions attributed to the project activity under scenario 1 include the following:

- (a) In the case of project activities that introduce an anaerobic digester for the treatment of wastewater, solid materials or sludge. Use the latest approved version of the tool “Project and leakage emissions from anaerobic digesters” to calculate project emissions;

The project emissions associated with the anaerobic digester are determined as follows:

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

$$PE_{AD,y} = PE_{EC,y} + PE_{FC,y} + PE_{CH_4,y} + PE_{flare,y} \quad (12)$$

Where:

- $PE_{AD,y}$  = Project emissions associated with the anaerobic digester in year  $y$  (tCO<sub>2</sub>)
- $PE_{EC,y}$  = Project emissions from electricity consumption associated with the anaerobic digester in year  $y$  (tCO<sub>2</sub>)
- $PE_{FC,y}$  = Project emissions from fossil fuel consumption associated with the anaerobic digester in year  $y$  (tCO<sub>2</sub>)
- $PE_{CH_4,y}$  = Project emissions of methane from the anaerobic digester in year  $y$  (tCO<sub>2</sub>)
- $PE_{flare,y}$  = Project emissions from flaring of biogas in year  $y$  (tCO<sub>2</sub>)

These parameters are determined through the steps outlined below.

### **Step 1: Determination of the quantity of methane produced in the digester ( $Q_{CH_4,y}$ )**

There are two different procedures to determine the quantity of methane produced in the digester in year  $y$ . For large-scale projects only Option 1 shall be used. For small-scale projects, project participants may choose between Option 1 or Option 2.

#### **Option 1: Procedure using monitored data**

To determine the quantity of methane produced in digester in the project activity will be monitored and calculated as per the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream”. When applying the tool, the following applies:

- The gaseous stream to which the tool is applied is the biogas collected from the digester
- CH<sub>4</sub> is the greenhouse gas for which the mass flow should be determined
- The flow of the gaseous stream should be measured on an hourly basis or a smaller time interval; and then accumulated for the year.

Option A of tool to determine the mass flow of a greenhouse gas in a gaseous stream is selected to calculate mass flow of methane in the residual gaseous stream on dry basis which is provided below in the section below in **Step 5**. The quantity of methane produced in digester ( $Q_{CH_4,y}$ ) is referred to the determination of the mass flow of methane ( $F_{CH_4,RG,m}$ ) as kg unit in the residue gaseous stream in the minute “m”.

**Step 2: Determination of project emissions from electricity consumption ( $PE_{EC,y}$ )**

This emission source includes CO<sub>2</sub> emissions from the consumption of electricity or combustion of fossil fuels for the operation of the project activity. As the project activity consumes electricity, the “Tool to calculate baseline, project and/or leakage emission from electricity consumption” Version 01 is applied to calculate project emission from electricity consumption ( $PE_{EC,y}$ ).

Option 1: Procedure using monitored data

As per the tool, the *Scenario A – Option A1: Electricity consumption from the grid* is applied to the project activity for the amount of electricity imported from the grid. The generic approach is used to calculate the project emissions as follows:

$$PE_{EC,y} = \sum EC_{PJ,j,y} \times EF_{EL,j,y} \times (1 + TDL_{j,y}) \quad (13)$$

Where:

- $PE_{power,y}$  = Project emissions from electricity consumption in year y (tCO<sub>2</sub>)
- $EC_{PJ,j,y}$  = Quantity of electricity consumed by the project electricity consumption source j in year y (MWh)
- $EF_{EL,j,y}$  = Emission factor for electricity generation source j in year y (tCO<sub>2</sub>/MWh)
- $TDL_{j,y}$  = Average technical transmission and distribution losses for providing electricity to source j in year y. A default value of 20% shall be assumed as conservative assumption as per applied tool.
- j = Source of electricity consumption in the project

**Determination of emission factor for the electricity generation ( $EF_{EL,j,y}$ )**

Option A1 has been used to determine emission factor. This option proposes to calculate the combined margin emission factor of the applicable electricity system, using the procedures in the latest approved version of the “Tool to calculate the emission factor for an electricity system, version 02.1.1” ( $EF_{EL,j,y} = EF_{CO2,grid,y}$ ). The grid emission factor details are further explained in Appendix 4 of the registered PDD.

**Determination of average technical transmission and distribution losses**

As per the registered PDD,  $TDL_{j,y}$  is based on the default value of 20% due to no data is available from the host country. The parameter is fixed at the time of validation.

**Step 3: Determination of project emissions from fossil fuel consumption ( $PE_{FC,y}$ )**

There is no fossil fuel consumption at the project site therefore; project emissions from fossil fuel consumption are not determined.

**Step 4: Determination of project emissions of methane from the anaerobic digester ( $PE_{CH4,y}$ )**

Project emissions of methane from the anaerobic digester include emissions during maintenance of the digester, physical leaks through the roof and sidewalls, and release through safety valves due to excess pressure in the digester. These emissions are calculated using a default emission factor as follows:

$$PE_{CH4,y} = Q_{CH4,y} \times EF_{CH4,default} \times GWP_{CH4} \quad (14)$$

Where:

- $PE_{CH4,y}$  = Project emissions of methane from anaerobic digester in year y (tCO<sub>2</sub>)
- $Q_{CH4,y}$  = Quantity of methane produced in the anaerobic digester in year y (tCH<sub>4</sub>)

- $EF_{CH_4, default}$  = Default emission factor for the fraction of  $CH_4$  produced that leaks from the anaerobic digester (fraction)  
 $GWP_{CH_4}$  = Global warming potential of  $CH_4$  ( $tCO_2/tCH_4$ )

### **Step 5: Determination of project emissions from flaring of biogas ( $PE_{flare,y}$ )**

This step is applicable for proposed project activity because the biogas is generated in a new anaerobic digester is flared partly. Methane may be released as a result of incomplete combustion in the flare. To calculate project emission from flaring of the biogas ( $PE_{flare}$ ) apply the latest approved version of the tool “Project emissions from flaring”. In general all of the biogas produced by the project is utilized for heat generation. However, a small amount of the biogas produced will be flared in an open flare, for instance during maintenance of the boilers or excess biogas. So the flaring system will be installed by the project activity to combust the biogas.

Methane may be released as a result of incomplete combustion in the flare. To calculate project emissions from flaring of the biogas ( $PE_{flare}$ ), the tool “Project emissions from flaring” (version 02.0.0) is applied.

For determination of the flare efficiency, a default value of 50% shall be used for the calculation of project emissions from flaring gases, based on the fact that an open flare will be employed in the project activity.

The project emissions calculation procedure is given in the following steps:

#### **STEP 1 Determination of the methane mass flow of the residual gas**

The “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” is used to determine the following parameter:

$F_{CH_4, RG, m}$  : Mass flow of methane in the residual gaseous stream in the minute  $m$  (kg)

$F_{CH_4, RG, m}$ , which is measured as the mass flow during minute  $m$ , shall then be used to determine the mass of methane in kilograms fed to the flare in minute  $m$  ( $F_{CH_4, RG, m}$ ).  $F_{CH_4, RG, m}$  shall be determined on a dry basis. Therefore, the measurement option A as per the table 1 of the tool is selected in order to determine the volume flow and the volumetric fraction of the residue gaseous stream on the dry basis. The temperature of the gaseous stream is less than 60 deg C at the flow measurement point. Therefore as per Option A (b), the gaseous stream is considered dry.

$F_{CH_4, RG, m}$  is determined as following equation;

$$F_{CH_4, RG, m} = V_{m, db} * v_{CH_4, m, db} * \rho_{CH_4, m} \quad (15)$$

Where:

- $F_{CH_4, RG, m}$  = Mass flow of greenhouse gas  $CH_4$  in the residual gaseous stream in the minute  $m$   
 $V_{m, db}$  = Volumetric flow of the residual gaseous stream in minute  $m$  on dry basis ( $Nm^3$ )  
 $v_{CH_4, m, db}$  = Volumetric fraction of the greenhouse gas  $CH_4$  in the gaseous stream in minute  $m$  on dry basis (%).  
 $\rho_{CH_4, m}$  = Density of greenhouse gas  $CH_4$  in the gaseous stream in minute  $m$  at normal conditions

Density of methane ( $\rho_{CH_4, m}$ ) is determined at the normal condition in line with below equation. The measurement of biogas flow is conducted in normalized unit ( $Nm^3$ ).

$$\rho_{i,t} = \frac{P_t \times MM_i}{R_u \times T_t}$$

Where:

$\rho_{CH_4,m}$	= Density of greenhouse gas (CH <sub>4</sub> ) in the gaseous stream in minute $m$
$P_t$	= Absolute pressure of the gaseous stream in time interval $t$ (Pa)
$MM_{CH_4}$	= Molecular mass of CH <sub>4</sub> (kg/kmol)
$R_u$	= Universal ideal gases constant (Pa.m <sup>3</sup> /kmol.K)
$T_i$	= Temperature of the gaseous stream in time interval $t$ (K)

### STEP 2 Determination of flare efficiency

#### Open flare:

In case of emergency only, biogas will be sent for open flaring. In the case of open flares, the flare efficiency in the minute  $m$  ( $\eta_{flare,m}$ ) is 50% when the flame is detected in the minute  $m$  (Flame  $m$ ) and otherwise the flare efficiency is 0%.

#### Enclosed flare:

As per the tool of project emission from flaring version 2, the project participant chooses the option A: apply a default value for flare efficiency. The flare efficiency for the minute  $m$  ( $\eta_{flare,m}$ ) is 90% when the following two conditions are met to demonstrate that the flare is operating:

- (1) The temperature of the flare ( $T_{RG,m}$ ) and the flow rate of the residual gas to the flare ( $F_{RG,m}$ ) is within the manufacturer's specification for the flare ( $SPEC_{flare}$ ) in minute  $m$ :  
and
- (2) The flame is detected in minute  $m$  (Flare <sub>$m$</sub> )

The enclosed flare of the project is defined as low height flare. The flare efficiency in the minute  $m$  shall be adjusted, as a conservative approach, by subtracting 0.1 from the efficiency. Therefore, The flare efficiency for the minute  $m$  ( $\eta_{flare,m}$ ) of 80% will be applied. If the above condition is not complied,  $\eta_{flare,m}$  is 0%.

### STEP 3 Calculation of project emissions from flaring

Project emissions from flaring are calculated as the sum of emissions for each minute  $m$  in year  $y$ , based on the methane mass flow in the residue gas ( $F_{CH_4,RG,m}$ ) and the flare efficiency ( $\eta_{flare,m}$ ), as follow:

$$PE_{flare,y} = \sum F_{CH_4,RG,h} * (1 - \eta_{flare-h}) * GWP_{CH_4} / 1000 \quad (16)$$

Where:

$PE_{flare,y}$	= Project emissions from flaring of the residual gas in year $y$ (tCO <sub>2</sub> )
$GWP_{CH_4}$	= Global warming potential of methane valid for the commitment period (tCO <sub>2</sub> /tCH <sub>4</sub> )
$F_{CH_4,RG,m}$	= Mass flow of methane in the residue gas in the minute $m$ (kg)
$\eta_{flare,m}$	= Flare efficiency in minute $m$

#### (i) Project emissions from land application of sludge

This emission source is only applicable if under the project activity sludge is applied on lands. For conservativeness, an MCF of 0.05 is to be used to estimate possible methane emissions from the land application treatment process to account for any possible anaerobic pockets. These emissions are to be estimated from the following equations:

(17)



$$PE_{\text{sludge,LA,y}} = \text{COD}_{\text{sludge, LA,y}} * B_o * \text{MCF}_{\text{sludge,LA}} * \text{GWP}_{\text{CH}_4} + S_{\text{LA,y}} * w_{\text{N,sludge,y}} * \text{EF}_{\text{N}_2\text{O, LA, sludge}} * \text{GWP}_{\text{N}_2\text{O}}$$

Where:

$PE_{\text{sludge,LA,y}}$	= Project emissions from land application of sludge in year $y$ (tCO <sub>2</sub> /yr)
$\text{COD}_{\text{sludge, LA,y}}$	= Chemical oxygen demand (COD) of the sludge applied to land after the dewatering process in year $y$ (tCOD/yr)
$B_o$	= Maximum methane producing capacity, expressing the maximum amount of CH <sub>4</sub> that can be produced from a given quantity of chemical oxygen demand (tCH <sub>4</sub> /tCOD)
$\text{MCF}_{\text{sludge,LA}}$	= Methane conversion factor for the application of sludge to lands
$\text{GWP}_{\text{CH}_4}$	= Global Warming Potential of methane valid for the applicable commitment period (tCO <sub>2</sub> /tCH <sub>4</sub> )
$W_{\text{sludge,COD,m}}$	= Average chemical oxygen demand in the sludge applied to land after the dewatering process in month $m$ (t COD/t sludge)
$S_{\text{LA,m}}$	= Amount of sludge applied to land in month $m$ (t sludge/month)
$N_{\text{sludge,LA,y}}$	= Amount of nitrogen in the sludge applied to land in year $y$ (t N/yr)
$W_{\text{N,sludge,m}}$	= Mass fraction of nitrogen in the sludge applied to land in month $m$ (t N/t sludge)
$\text{EF}_{\text{N}_2\text{O, LA, sludge}}$	= N <sub>2</sub> O emission factor for nitrogen from sludge applied to land (t N <sub>2</sub> O/t N)
$\text{GWP}_{\text{N}_2\text{O}}$	= Global Warming Potential of nitrous dioxide (tCO <sub>2</sub> /tN <sub>2</sub> O)

In this monitoring, the sludge from the project activity is directly applied on the plantation area and is not stored under anaerobic conditions at any point of time. Thus, the project emissions from land application of sludge shall not be accounted and shall be zero inline with the tool and the methodology.

## (ii) Project emissions from land application of dewatered

According to ACM0014, version 05.0.0, this emission source is only applicable if under the project activity wastewater is dewatered and directed to land applicable. In the proposed project activity, the wastewater is not dewatered and directed to land. Therefore, project emissions from land application of wastewater are neglected.

**Table of calculation of project emissions**

Project emissions		2017	2018
		01/07 to 31/12	01/01 to 30/06
$PE_{\text{AD,y}}$	tCO <sub>2</sub>	44,626	15,561
$PE_{\text{sludge,LA,y}}$	tCO <sub>2</sub>	0	0
$PE_{\text{WW,LA,y}}$	tCO <sub>2</sub>	0	0
$PE_y$ (round up)	tCO <sub>2</sub>	44,627	15,561

## E.3. Calculation of leakage emissions

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As per ACM0014 Version 05, project activities that introduce an anaerobic digester for the treatment of wastewater, solid materials or sludge leakage emissions are accounted using the tool "Project and leakage emissions from anaerobic digesters". The following equation is considered;

$$LE_y = LE_{\text{AD}} = LE_{\text{storage}} + LE_{\text{comp,y}} \quad (18)$$

Where:

$LE_{AD}$  = Leakage emissions associated with the anaerobic digester in year y (tCO<sub>2</sub>e/yr)  
 $LE_{storage}$  = Leakage emissions associated with storage of digestate in year y (tCO<sub>2</sub>e/yr)  
 $LE_{comp,y}$  = Leakage emissions associated with composting digestate in year y (tCO<sub>2</sub>e/yr)

As per the tool, the leakage emissions associated with the anaerobic digester ( $LE_{AD,y}$ ) depend on how the digestate is managed. In this monitoring period, the wastewater treated at the outlet of the project was supplied to open ponds. This effluent treated was considered as the digestate. Therefore, the leakage emission is only determined the leakage emission associated with storage of digestate ( $LE_{storage}$ ). The option 1 of procedure using monitored data is chosen as following equation;

$$LE_{AD} = LE_{storage} = Q_{stored,y} \times P_{COD,y} \times B_o \times MCF_P \times GWP_{CH_4} \quad (19)$$

Where:

$LE_{AD}$  = Leakage emissions associated with the anaerobic digester in year y (tCO<sub>2</sub>e/yr)  
 $LE_{storage}$  = Leakage emissions associated with storage of digestate in year y (tCO<sub>2</sub>e/yr)  
 $Q_{stored,y}$  = Amount of liquid digestate stored anaerobically in year y (m<sup>3</sup>)  
 $P_{COD,y}$  = Average chemical oxygen demand (COD) of the liquid digestate in year y (tCOD/m<sup>3</sup>)  
 $MCF_P$  = Leakage emissions associated with composting digestate in year y (tCO<sub>2</sub>e/yr)  
 $B_o$  = Maximum methane producing capacity of the COD applied (tCH<sub>4</sub>/tCOD)  
 $GWP_{CH_4}$  = Global warming potential of CH<sub>4</sub> (tCO<sub>2</sub>/tCH<sub>4</sub>)

The monitoring detail of  $Q_{stored,y}$  is referred to the monitoring parameter  $F_{PJ,dig,m}$ . While, the monitoring detail of  $P_{COD}$  is referred to the monitoring parameter  $COD_{discharge,m}$ . As per this tool, parameter  $B_o$  value - the maximum CH<sub>4</sub> producing capacity of the COD applied of 0.25 is applied in the emission reduction calculation.

**Table of calculation of Leakage**

Leakage		2017	2018
		01/07 to 31/12	01/01 to 30/06
$LE_y$ (round up)	tCO <sub>2</sub>	3,579	585

#### E.4. Calculation of emission reductions or net anthropogenic removals

	Baseline GHG emissions or baseline net GHG removals (t CO <sub>2</sub> e)	Project GHG emissions or actual net GHG removals (t CO <sub>2</sub> e)	Leakage GHG emissions (t CO <sub>2</sub> e)	GHG emission reductions or net anthropogenic GHG removals (t CO <sub>2</sub> e)		
				Before 01/01/2013	From 01/01/2013	Total amount
<b>Total</b>	130,143	60,188	4,163	0	65,792	65,792

#### E.5. Comparison of emission reductions or net anthropogenic removals achieved with estimates in the registered PDD

Amount achieved during this monitoring period (t CO <sub>2</sub> e)	Amount estimated ex ante (t CO <sub>2</sub> e)
65,791	204,921

**E.6. Remarks on increase in achieved emission reductions**

As per the above calculation detail, the actual GHG emission reduction achieved in the monitoring period is lower than the amount based on the ex-ante estimation in the registered PDD. This section is not applicable.

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