Approved consolidated baseline and monitoring methodology ACM0014

"Mitigation of greenhouse gases emissions from treatment of industrial wastewater" ~~Avoided methane emissions from wastewater treatment"~~

I. SOURCE, DEFINITIONS AND APPLICABILITY

Sources

This consolidated methodology is based on the following submissions:

- NM0038-rev: Methane Gas Capture and Electricity Production at Chisinau Wastewater Treatment Plant project, Moldova prepared by COWI A/S, Denmark;
- NM0039: Bumibiopower Methane Extraction and Power Generation Project, Malaysia, prepared by Mitsubishi Securities;
- NM0085: Vinasse Anaerobic Treatment Project prepared by Compañía Licorera de Nicaragua, S. A.;
- NM0041-rev2: Korat Waste To Energy Project, Thailand, prepared by EcoSecurities Ltd.

and the following approved methodologies:

- AM0013: Avoided methane emissions from organic waste-water treatment - Version 4;
- AM0022: Avoided Wastewater and On-site Energy Use Emissions in the Industrial Sector - Version 4.

This methodology also refers to the latest approved versions of the following:

- "Tool for the demonstration and assessment of additionality";
- "Tool to determine project emissions from flaring gases containing methane";
- "Tool to calculate the emission factor for an electricity system";
- "Tool to calculate project emissions from electricity consumption";
- "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion".

For more information regarding the proposals and ~~its~~ their considerations by the Executive Board please refer to: <http://cdm.unfccc.int/methodologies/PAmethodologies/approved.html>.

Selected approach from paragraph 48 of the CDM modalities and procedures

"Existing actual or historical emissions, as applicable"; or

"Emissions from a technology that represents an economically attractive course of action, taking into account barriers to investment".

Definitions

For the purpose of this methodology, the following definitions apply:

Sludge pits. A pit or tank where untreated liquid sludge is pumped and stored for at least one year. Anaerobic bacteria decompose the liquid sludge and decrease the organic matter content, resulting in emissions of CO_2, CH_4, hydrogen sulphide (H_2S) and ammonia. Once the pits are dried out and the sludge is stable, the solids are removed and used, e.g., as fertiliser for non-food crops;

Anaerobic digester. I ~~i~~n an anaerobic digester the biodegradable fraction of sludge or wastewater is converted into CH_4 and CO_2 by a complex of bacteria. These gases (biogas) are collected in a controlled way. Several designs of anaerobic digesters are possible. The biogas can be used for electricity production, for heating purposes, or it can be flared.

Applicability

This methodology is applicable to project activities that aim at reducing ~~avoid~~ methane emissions from industrial wastewater treatment. The methodology is applicable to the scenarios described in Table 1.[1]

Table 1: Scenarios applicable to the methodology

Scenario	Description of the baseline situation	Description of the project activity
1	The wastewater is not treated, but directed to open lagoons that have clearly anaerobic conditions.	The wastewater is treated in a new anaerobic digester. The biogas extracted from the anaerobic digester is flared and / or used to generate electricity and / or heat. The residual from the anaerobic digester after treatment is directed to open lagoons or is treated under clearly aerobic conditions (e.g. dewatering and land application).
2	The wastewater is treated in a wastewater treatment plant. Sludge is generated from primary and / or secondary settlers. The sludge is directed to sludge pit(s) that have clearly anaerobic conditions.	The wastewater is treated in the same wastewater treatment plant as in the baseline situation. The sludge from primary and / or secondary settler is treated in one or both of the following ways: (a) The sludge is treated in a new anaerobic digester. The biogas extracted from the anaerobic digester is flared and / or used to generate electricity and / or heat. The residual from the anaerobic digester after treatment is directed to open lagoons or is treated under clearly aerobic conditions (e.g. dewatering and land application). (b) The sludge is treated under clearly aerobic conditions (e.g. dewatering and land application).

[1] Note that the most likely baseline scenario is an outcome of the application of the procedure to select the most plausible baseline scenario, as described below.

Project participants should document in the CDM-PDD which scenario applies and clearly describe the situation before and after the start of implementation of the project activity, preferably by providing similar diagrams as contained in Appendix I, which provides an example for application of Scenario 2.

The following applicability conditions are for all scenarios:

- The average depth of the open lagoons or sludge pits in the baseline scenario is at least 1 m.[2] ;
- Heat and electricity requirements per unit input of the water treatment facility remain largely unchanged in the baseline scenario and the project activity;
- Data requirements as laid out in this methodology are fulfilled.

The following applicability conditions are for scenario 1:

- The residence time of the organic matter in the open lagoon system should be at least 30 days[3];
- Local regulations do not prevent discharge of wastewater in open lagoons.

The following applicability condition is for scenario 2:

- The sludge produced during the implementation of the project activity is not stored onsite before land application to avoid any possible methane emissions from anaerobic degradation[4].

II. BASELINE METHODOLOGY

Project boundary

The spatial extent of the project boundary includes:

- The site where the wastewater is treated in both the baseline and the project scenario;
- The sites where any sludge is applied to lands;
- Any on-site power plants that supply electricity to the wastewater or sludge treatment system;

[2] In particular, loading in the wastewater streams has to be high enough to assure that the lagoon develops an anaerobic bottom layer and that algal oxygen production can be ruled out. For project activities implemented in Greenfield facilities, the depth should be based on the design of the baseline lagoon as explained in the section "Identification of alternative scenarios".

[3] In case of an existing open lagoon in the baseline scenario the residence time of the organic matter in the lagoon should be verified based on historical data available. In the case where the baseline is a new to be built anaerobic lagoon, the residence time should be based on the design of the baseline lagoon as explained in the section "Identification of alternative scenarios".

- Any on-site facilities to generate heat that is used by the wastewater or sludge treatment systems;
- If applicable, the anaerobic digester, the power and / or heat generation equipment and / or the flare installed under the project activity;
- If applicable, any dewatering system installed under the project activity;
- If grid electricity is displaced from electricity generation with biogas from an aerobic digester: the power plants connected to the grid, with the geographical boundary as specified in the latest approved version of the "Tool to calculate the emission factor for an electricity system".

The emission sources included in the project boundary are described in Table 2 below.

Table 2: Emission sources included and excluded from the project boundary

	Source	**Gas**		**Justification / Explanation**
Baseline	Wastewater treatment processes or sludge disposal	CH_4	Included	The major source of emissions in the baseline from open lagoons (scenario 1) or disposal of sludge (scenario 2)
		N_2O	Excluded	Excluded for simplification. This is conservative.
		CO_2	Excluded	CO_2 emissions from the decomposition of organic waste are not accounted for
	Electricity consumption / generation	CO_2	Included	Electricity may be consumed for the operation of the wastewater or sludge treatment system in the baseline scenario. If electricity is generated with biogas from an anaerobic digester under the project activity, electricity generation in the grid or on-site is displaced by the project activity.
		CH_4	Excluded	Excluded for simplification. This is conservative.
		N_2O	Excluded	Excluded for simplification. This is conservative.
	Thermal energy generation	CO_2	Included	If thermal energy is generated with biogas from an anaerobic digester under the project activity, on-site thermal energy generation is displaced by the project activity
		CH_4	Excluded	Excluded for simplification. This is conservative.
		N_2O	Excluded	Excluded for simplification. This is conservative.
Project Activity	Wastewater treatment processes or sludge treatment process	CH_4	Included	The treatment of wastewater or sludge under the project activity may cause different emissions: (i) Methane emissions from the lagoons (if effluent from the treatment under the project activity is directed to lagoons); (ii) Physical leakage of methane from the digester system; (iii) Methane emissions from flaring (if biogas from the digester is flared); (iv) Methane emissions from land application of sludge; (v) Methane emissions from wastewater removed in the dewatering process.

		CO_2	Excluded	CO_2 emissions from the decomposition of organic waste are not accounted for
		N_2O	Included	In case of projects that involve land application of sludge
	On-site electricity use	CO_2	Included	May be an important emission source. If electricity is generated with biogas from an anaerobic digester, these emissions are not accounted for. Any on-site electricity consumption should be subtracted from the electricity generation of the digester.
		CH_4	Excluded	Excluded for simplification. This emission source is assumed to be very small.
		N_2O	Excluded	Excluded for simplification. This emission source is assumed to be very small.
	On-site fossil fuel consumption	CO_2	Included	May be an important emission source.
		CH_4	Excluded	Excluded for simplification. This emission source is assumed to be very small.
		N_2O	Excluded	Excluded for simplification. This emission source is assumed to be very small.

Procedure for the identification of the most plausible baseline scenario

Project participants shall determine the most plausible baseline scenario through the application of the following steps.

Step 1: Identification of alternative scenarios

Depending on the type of a project activity (i.e. whether scenario 1 or 2 applies, whether electricity is generated, etc), project participants shall identify realistic and credible alternatives with regard to the possible scenarios that would occur in the absence of the project activity. Make sure that all scenarios include the proposed project activity not being registered under the CDM.

For all project configurations, plausible alternative scenarios for the treatment of wastewater (W) should be determined. These may include, but are not limited to, the following:

W1. The use of open lagoons for the treatment of the wastewater;
W2. Direct release of wastewaters to a nearby water body;
W3. Aerobic wastewater treatment facilities (e.g., activated sludge or filter bed type treatment);
W4. Anaerobic digester with methane recovery and flaring;
W5. Anaerobic digester with methane recovery and utilization for electricity or heat generation.

For project activities implemented in Greenfield facilities, the specifications of the W1 scenario shall be defined following four steps:

(a) Define several lagoon design options for the particular wastewater stream that meet the relevant regulations and take into consideration local conditions (e.g. environmental legislation, ground water table, land requirement, temperature). Design specifications shall include average depth and surface area of the lagoon, electricity consumption (EC_{BL}), residence time of the organic matter and effluent adjustment factor (AD_{Bl}), as well as any other key parameters. Document the different design options in a transparent manner and provide transparent and documented evidence of key assumptions and data used, and offer conservative interpretations of this evidence;

(b) Carry out an economic assessment of the identified options, as per the guidance under Step 4 below. Choose the least cost lagoon design option from the options defined in Step 1 taking into account all relevant local conditions (e.g. land requirements, land prices, ground water level). If several options with comparably low costs exist, choose the one with the lowest lagoon depth as the baseline lagoon design;

(c) Verify the average depth of the baseline lagoon design, as determined in Step (b), based on a review of published literature establishing an average lagoon depth for a particular industry (particular type of waste water). If such literature does not exist, conduct a survey within the industry based on a control group of the five most recently constructed lagoon systems in the particular industry;

(d) If the average depth of the lagoon design option identified in Step (b) is deeper than the depth identified through literature review or the control group in Step (c), provide credible explanations why the assumptions of the least cost design are valid. The explanations have to be supported by credible evidences that the depth identified in Step (c) is not a feasible option for the project activity. Provide transparent and documented evidence, and offer conservative interpretations of this evidence.

In case of project activities implemented in Greenfield facilities, the DOE undertaking the validation shall include an interview with an independent wastewater expert. During the interview, the expert shall confirm i) the selection of the least cost lagoon design and its defined design parameters and ii) results of the literature review or the control group survey.

In case of scenario 2, plausible alternative scenarios for the treatment of sludge (S) should be determined. These may include, but are not limited to, the following:

S1. Disposal of sludge in sludge pits under clearly anaerobic conditions;
S2. Land application of the sludge;
S3. Landfilling;
S4. Composting;
S5. Aerobic composting;
S6. Mineralization.

If the project activity includes electricity generation with biogas from a new anaerobic digester, plausible alternative scenarios for the generation of electricity should be determined. These may include, but are not limited to, the following:

E1. Power generation using fossil fuels in a captive power plant;
E2. Electricity generation in the grid;
E3. Electricity generation using renewable sources.

If the project activity includes heat generation with biogas from a new anaerobic digester, plausible alternative scenarios for the generation of heat should be determined. These may include, but are not limited to, the following:

H1. Co-generation of heat using fossil fuels in a captive cogeneration power plant;
H2. Heat generation using fossil fuels in a boiler;
H3. Heat generation using renewable sources.

The suggested list of alternatives is only indicative. Project participants may propose other plausible alternatives and / or eliminate some of the ones listed above, based on documented evidence.

Identify realistic and credible combinations of scenarios for wastewater treatment (W) and, where applicable, the treatment of sludge (S), the generation of electricity (E) and the generation of heat (H). These combinations should be considered in the next steps.

Step 2: Eliminate alternatives that are not complying with applicable laws and regulations

Eliminate alternatives that are not in compliance with all applicable legal and regulatory requirements. Apply Sub-step 1b of the latest version of the “Tool for the demonstration and assessment of additionality” agreed by the CDM Executive Board.

Step 3: Eliminate alternatives that face prohibitive barriers

Scenarios that face prohibitive barriers should be eliminated by applying Step 3 of the latest version of the “Tool for the demonstration and assessment of additionality” agreed by the CDM Executive Board.

If only one alternative remains, this can be considered the baseline. If more than one alternative remains, proceed to Step 4.

Step 4: Compare economic attractiveness of remaining alternatives

Compare the economic attractiveness without revenues from CERs for all alternatives that are remaining by applying Step 2 of the latest approved version of the "Tool for the demonstration and assessment of additionality". In applying the investment analysis, the IRR should be used as indicator. The following parameters should explicitly be documented:

- Land cost;
- Engineering, Procurement and Construction cost;
- Labour cost;
- Operation and Maintenance cost;
- Administration cost;
- Fuel cost;
- Capital cost and interest;
- Revenue from electricity sales;
- All other costs of implementing the technology of the each alternative option;
- All revenues generated by the implementation of the proposed technology except for carbon credits revenues (including energy savings due to captive use of biogas as fuel for either electricity or heat generation at the project site).

In the case that there are several alternatives remaining after Step 2 and that at least two alternatives are associated with costs, an investment comparison analysis should be conducted. In doing so, compare the IRR of the different alternatives and select the most cost-effective alternative (i.e. with the highest IRR) as the baseline scenario. Include a sensitivity analysis applying Sub-step 2d of the latest version of the "Tool for the demonstration and assessment of additionality" agreed by the CDM Executive Board. The investment comparison analysis provides a valid argument that the most cost-effective scenario is the baseline scenario if it consistently supports (for a realistic range of assumptions) this conclusion. In case the sensitivity analysis is not fully conclusive, select the baseline scenario alternative with least emissions among the alternatives that are the most economically attractive according to the investment analysis and the sensitivity analysis.

In the case the project undertaken without being registered as a CDM project activity is the only remaining alternative with associated costs, a benchmark analysis is to be used to demonstrate its profitability or non-profitability. If the project is profitable, it is to be considered as the baseline scenario. If not, the continuation of the current situation is the baseline.

The methodology is only applicable if it can be demonstrated that the baseline scenario corresponds to the scenario described in Table 1 above and if the following baseline scenarios are most likely:

- For scenario 1: W1 for the treatment of wastewater and, if applicable, E1 / E2 for the generation of electricity;
- For scenario 2: W3 for the treatment of wastewater, S1 for the use of the sludge and, if applicable, E1 / E2 for the generation of electricity.

Additionality

Use the latest version of the "Tool for the demonstration and assessment of additionality" agreed by the CDM Executive Board. In doing so, ensure consistency with the guidance provided in the "Procedure for the identification of the most plausible baseline scenario". If the baseline scenario of ~~Greenfield~~ a project activity implemented in a Greenfield facility-is the use of open lagoons, additionality assessment shall be conducted on the basis of the lagoon parameters defined in Step 1 of the "Procedure for the identification of the most plausible baseline scenario".

Baseline emissions

Baseline emissions are estimated as follows:

$$BE_y = BE_{CH4,y} + BE_{EL,y} + BE_{HG,y} \tag{1}$$

Where:

BE_y	=	Baseline emissions in year *y* (tCO_2e / yr)
BE_{CH4}	=	Methane emissions from anaerobic treatment of the wastewater in open lagoons (scenario 1) or the anaerobic treatment of sludge in sludge pits (scenario 2) in the absence of the project activity in year *y* (tCO_2e / yr)
$BE_{EL,y}$	=	CO_2 emissions associated with electricity generation that is displaced by the project activity and / or electricity consumption in the absence of the project activity in year *y* (tCO_2 / yr)
$BE_{HG,y}$	=	CO_2 emissions associated with fossil fuel combustion for heating equipment that is displaced by the project in year *y* (tCO_2 / yr)

Baseline emissions are calculated in three steps, as follows:

Step 1: Calculation of baseline emissions from anaerobic treatment of the wastewater or sludge;
Step 2: Calculation of baseline emissions from generation and consumption of electricity (if applicable);
Step 3: Calculation of baseline emissions from heat generation (if applicable);

Steps 2 and 3 are only applicable if electricity or heat is generated from biogas generated in the anaerobic digester.

Step 1: Calculation of baseline emissions from anaerobic treatment of the wastewater or sludge

The methodology proposes two alternative methods for the estimation of methane emissions from open lagoons:

(a) The Methane Conversion Factor Method (described in Step 1a); and
(b) The Organic Removal Ratio Method (described in Step 1b).

Project participants should document in the CDM-PDD which method is applied. The method chosen should be applied throughout all crediting periods. If~~n~~ the project activity is implemented in a Greenfield facility, only the Methane Conversion Factor Method applies.

Step 1a: Methane Conversion Factor Method

The baseline methane emissions from anaerobic treatment of the wastewater in open lagoons (scenario 1) or the anaerobic treatment of sludge in sludge pits (scenario 2) are estimated based on the chemical oxygen demand (COD) of the wastewater that would enter the lagoon in the absence of the project activity ($COD_{PJ,y}$), 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:

$$BE_{CH4,y} = GWP_{CH4} \times MCF_{BL,y} \times B_o \times COD_{BL,y} \qquad \textbf{(2)}$$

Where:

BE_{CH4}	=	Methane emissions from anaerobic treatment of the wastewater in open lagoons (scenario 1) or the anaerobic treatment of sludge in sludge pits (scenario 2) in the absence of the project activity in year *y* (tCO_2e / yr)
GWP_{CH4}	=	Global Warming Potential of methane valid for the commitment period (tCO_2e / tCH_4)
B_o	=	Maximum methane producing capacity, expressing the maximum amount of CH_4 that can be produced from a given quantity of chemical oxygen demand (tCH_4 / tCOD)
$MCF_{BL,y}$	=	Average baseline methane conversion factor (fraction) in year *y*, representing the fraction of ($COD_{PJ,y}$ x B_o) that would be degraded to CH_4 in the absence of the project activity
$COD_{BL,y}$	=	Quantity of chemical oxygen demand that would be treated in open lagoons (scenario 1) or in sludge pits (scenario 2) in the absence of the project activity in year *y* (tCOD/yr)

Determination of $COD_{BL,y}$

In principle, the baseline chemical oxygen demand ($COD_{BL,y}$) corresponds to the chemical oxygen demand that is treated under the project activity ($COD_{PJ,y}$) because the wastewater (scenario 1) or sludge (scenario 2) treated under the project activity would in the absence of the project activity be directed to the open lagoon (scenario 1) or the sludge pit (scenario 2), and thus $COD_{BL,y} = COD_{PJ,y}$.

If there would be an effluent from the lagoons (scenario 1) or the sludge pit (scenario 2) in the baseline, COD_{BL} should be adjusted by an effluent adjustment factor which relates the COD supplied to the lagoon or sludge pit with the COD in the effluent, as follows:

$$COD_{BL,y} = AD_{BL} \times COD_{PJ,y} \qquad \textbf{(3)}$$

Where:

$COD_{BL,y}$	=	Quantity of chemical oxygen demand that would be treated in open lagoons (scenario 1) or in sludge pits (scenario 2) 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)
AD_{BL}	=	Effluent adjustment factor expression the percentage of COD that is degraded in open lagoons (scenario 1) or in sludge pits (scenario 2) in the absence of the project activity

AD_{BL} ~~may be~~ is determined ~~by different approaches~~ as follows:

For project activities implemented in existing facilities:

a) ~~For existing plants and if~~ In the case when at least one year historical data of the COD inflow and COD effluent ~~is~~ are available, AD_{BL} should be determined as follows:

$$AD_{BL} = 1 - \frac{COD_{out,x}}{COD_{in,x}} \quad \textbf{(4)}$$

Where:

AD_{BL}	=	Effluent adjustment factor expression the percentage of COD that is degraded in open lagoons (scenario 1) or in sludge pits (scenario 2) in the absence of the project activity
$COD_{out,x}$	=	COD of the effluent in the period *x* (t COD)
$COD_{in,x}$	=	COD directed to the open lagoons (scenario 1) or in sludge pits (scenario 2) in the period *x* (t COD)
x	=	Representative historical reference period (at least one year)

b) ~~For existing plants where at least~~ In the case when one year historical data of the COD inflow and COD effluent ~~is~~ are not available, AD_{BL} should be determined as follows:

> AD_{BL} is determined by conducting measurements of the COD inflow to and effluent from the lagoon or sludge pit during a measurement campaign of at least 10 days. The measurements should be undertaken during a period that is representative for the typical operation conditions of the plant and ambient conditions of the site (temperature, etc). The average COD_{in} and COD_{out} values from the measurement campaign shall be used in equation (4) and the result shall be multiplied by 0.89 to account for the uncertainty range (of 30% to 50%) associated with this approach as compared to one-year historical data.

For project activities implemented in Greenfield facilities:

> In the case of ~~Greenfield~~ projects ~~projects~~ activities implemented in Greenfield facilities, where the baseline is a new to be built anaerobic lagoon, AD_{BL} is determined based on the design features that were identified as the baseline in the procedure outlined in Step 1 of the "procedure for the identification of the most plausible baseline scenario", by using in equation (4) the design COD inflow for COD_{in} and the design effluent COD flow for COD_{out}.

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

$$COD_{PJ,y} = \sum_{m=1}^{12} F_{PJ,dig,m} \times w_{COD,dig,m} \quad \textbf{(5)}$$

Where:

$COD_{PJ,y}$ = 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)

$F_{PJ,dig,m}$ = Quantity of wastewater or sludge that is treated in the anaerobic digester or under clearly aerobic conditions in the project activity in month *m* (m^3 / month)

$w_{COD,dig,m}$ = Average chemical oxygen demand in the wastewater or sludge that is treated in the anaerobic digester or under clearly aerobic conditions in the project activity in month *m* (t COD / m^3)

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) or in sludge pits (scenario 2) depends mainly on the temperature and the depth of the lagoon or sludge pit. Accordingly, the methane conversion factor is calculated based on a factor f_d, expressing the influence of the depth of the lagoon or sludge pit 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:

$$MCF_{BL,y} = f_d \times f_{T,y} \times 0.89 \qquad \textbf{(6)}$$

Where:

$MCF_{BL,y}$ = Average baseline methane conversion factor (fraction) in year *y*, representing the fraction of ($COD_{PJ,y}$ x B_o) that would be degraded to CH_4 in the absence of the project activity

f_d = Factor expressing the influence of the depth of the lagoon or sludge pit on methane generation

$f_{T,y}$ = Factor expressing the influence of the temperature on the methane generation in year *y*

0.89 = Conservativeness factor

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 or sludge directed to a pit, 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 ($COD_{available,m}$) is assumed to be equal to the amount of organic matter directed to the open lagoon or sludge pit, less any effluent, plus the COD that may have remained in the lagoon or sludge pit from previous months, as follows:

$$COD_{available,m} = COD_{BL,m} + (1 - f_{T,m}) \times COD_{available,m-1} \quad \text{with} \qquad \textbf{(7)}$$

$$COD_{BL,m} = AD_{BL} \times COD_{PJ,m} \quad \text{and} \qquad \textbf{(8)}$$

$$COD_{PJ,m} = F_{PJ,dig,m} \times w_{COD,dig,m} \quad \textbf{(9)}$$

Where:

$COD_{available,m}$	=	Quantity of chemical oxygen demand available for degradation in the open lagoon or sludge pit in month *m* (t COD / month)
$COD_{BL,m}$	=	Quantity of chemical oxygen demand that would be treated in open lagoons (scenario 1) or in sludge pits (scenario 2) in the absence of the project activity in month *m* (t COD / month)
$COD_{PJ,m}$	=	Quantity of chemical oxygen demand that is treated in the anaerobic digester or under clearly aerobic conditions in the project activity in month *m* (t COD / month)
AD_{BL}	=	Effluent adjustment factor expressing the percentage of COD that is degraded in open lagoons (scenario 1) or in sludge pits (scenario 2) in the absence of the project activity
$F_{PJ,dig,m}$	=	Quantity of wastewater or sludge that is treated in the anaerobic digester or under clearly aerobic conditions in the project activity in month *m* (m^3 / month)
$w_{COD,dig,m}$	=	Average chemical oxygen demand in the wastewater or sludge that is treated in the anaerobic digester or under clearly aerobic conditions in the project activity in month *m* (t COD / m^3)
$f_{T,m}$	=	Factor expressing the influence of the temperature on the methane generation in month *m*
m	=	Months of year *y* of the crediting period

The carry-over calculations are limited to a maximum of one year. In case the residence time in the open lagoon or the sludge pit is less than one year, carry-on calculations are limited to the period where the wastewater remains in the lagoon or the sludge remains in the sludge pit. I.e., in the case of the emptying of a sludge pit, the accumulation of organic matter restarts with the next inflow and the COD available from the previous month should be set to zero. Project participants should provide evidence of the typical residence time of the organic matter in the lagoon or the sludge pit.

In the case of projects activities implemented 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:

$$f_{T,m} = \begin{cases} 0 & \text{if } \; T_{2,m} < 283\,K \\ \exp\left(\dfrac{E * (T_{2,m} - T_1)}{R * T_1 * T_{2,m}}\right) & \text{if } \; 283\,K < T_{2,m} < 303\,K \\ 1 & \text{if } \; T_{2,m} > 303\,K \end{cases} \quad \textbf{(10)}$$

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 (10) 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.

Based on the monthly values $f_{T,m}$ the annual value $f_{T,y}$ is calculated as follows:

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

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 or sludge pit in month *m* (t COD / month)
$COD_{BL,m}$	=	Quantity of chemical oxygen demand that would be treated in open lagoons (scenario 1) or in sludge pits (scenario 2) in the absence of the project activity in month *m* (t COD / month)
m	=	Months of year *y* of the crediting period

Step 1b: Organic removal ratio (ORR) method

The organic removal ratio method measures the reduction of chemical oxygen demand (COD) in a wastewater or sludge stream between its entry into and exit from the treatment system (the open lagoon or the sludge pit). The organic removal ratio is a project specific factor expressing the fraction of COD that is degraded in the open lagoon or sludge pit (i.e. between the entry and exit points).

Losses of COD in a sludge pit or lagoon system occur through three main routes:

- Anaerobic decomposition (and consequently methane emissions);
- Oxidative decomposition, either aerobic at the pond surface, or through chemical oxidation where there is a presence of an oxidizing product, such as sulphate from sulphuric acid (SO_4^{2-} from H_2SO_4);
- Sedimentation of certain suspended materials that can be lost through other routes, and settle to the lagoon bottom, remaining on a more or less permanent basis.

The organic removal ratio method acknowledges these different losses of COD. Baseline methane emissions from anaerobic treatment of the wastewater in open lagoons (scenario 1) or the anaerobic treatment of sludge in sludge pits (scenario 2) are estimated based on a mass balance of the organic matter, as follows:

$$BE_{CH4,y} = GWP_{CH4} \times B_o \times \left(COD_{BL,y} - COD_{aerobic,BL} - COD_{OX,BL,y} - COD_{sedim,BL,y}\right) \quad \textbf{(12)}$$

Where:

$BE_{CH4,y}$	=	Methane emissions from anaerobic treatment of the wastewater in open lagoons (scenario 1) or the anaerobic treatment of sludge in sludge pits (scenario 2) in the absence of the project activity in year *y* (tCO_2e / yr)
GWP_{CH4}	=	Global Warming Potential of methane valid for the commitment period (tCO_2e / tCH_4)
B_o	=	Maximum methane producing capacity, expressing the maximum amount of CH_4 that can be produced from a given quantity of chemical oxygen demand (tCH_4 / tCOD)
$COD_{BL,y}$	=	Quantity of chemical oxygen demand that would be treated in open lagoons (scenario 1) or in sludge pits (scenario 2) in the absence of the project activity in year *y* (t COD / yr)
$COD_{aerobic,BL}$	=	Annual quantity of chemical oxygen demand that would degrade aerobically in the lagoon or sludge pit (t COD / yr)
$COD_{OX,BL,y}$	=	Annual quantity of chemical oxygen demand that would be chemically oxidised through sulphate in the wastewater or sludge in year *y* (t COD / yr)
$COD_{sedim,BL,y}$	=	Amount of chemical oxygen demand lost through sedimentation in the lagoon or sludge pit before the start of the project activity (t COD / yr)

$COD_{BL,y}$ is determined as per equations (3), (4) and (5) for the methane conversion factor method.

Determination of $COD_{aerobic,BL}$

$COD_{aerobic,BL}$ is calculated based on the surface of the lagoon or sludge pit and a default value for the amount of COD per hectare that degrades under aerobic conditions, as follows:

$$COD_{aerobic,BL} = A \times f_{COD,aerobic} \quad \textbf{(13)}$$

Where:

$COD_{aerobic,BL}$	=	Annual quantity of chemical oxygen demand that would degrade aerobically in the lagoon or sludge pit (t COD / yr)
A	=	Surface of the lagoon or sludge pit (ha)
$f_{COD,aerobic}$	=	Quantity of chemical oxygen demand degraded to CO_2 under aerobic conditions per surface area of the lagoon or sludge pit (t COD / ha yr)

Determination of $COD_{OX,BL,y}$

The determination of this parameter is relevant if the wastewater or sludge contains chemical substances that chemically oxidize organic matter in the wastewater or sludge. The most likely chemical substance that may be present is the sulphate ion (SO_4^{2-}) from use in the process of sulphuric acid. Project participants should identify which chemical substances are relevant for the wastewater or sludge type. The concentration of these chemical substances is monitored and the reduction in chemical oxygen demand due to the chemical oxidation of organic matter is then determined as follows:

$$COD_{OX,BL,y} = F_{PJ,y} \times \sum_{s} w_{s,y} \times R_s \times 0.001 \quad (14)$$

$$F_{PJ,y} = \sum_{m} F_{PJ,dig,m} \quad (14a)$$

Where:

$COD_{OX,BL,y}$	=	Annual quantity of chemical oxygen demand that would be chemically oxidised through sulphate in the wastewater or sludge in year *y* (t COD / yr)
$F_{PJ,y}$	=	Quantity of wastewater or sludge treated in the digester in year *y* (m³ / yr)
$w_{s,y}$	=	Average concentration of chemical oxidative substance *s* in the wastewater or sludge treated in the digester in year *y* (kg / m³)
R_s	=	Specific reduction in chemical oxygen demand by substance *s* (t COD / t substance)
s	=	Substances in the wastewater or sludge that can chemically oxidize organic matter
$F_{PJ,dig,m}$	=	Quantity of wastewater or sludge that is treated in the anaerobic digester or under clearly aerobic conditions in the project activity in month *m*

Determination of $COD_{sedim,BL}$

To determine $COD_{sedim,BL,y}$ the procedure in Appendix II shall be applied.

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

In this step, baseline emissions from the following sources are estimated:

- Baseline emissions from consumption of electricity associated with the treatment of wastewater (scenario 1) or the treatment of sludge (scenario 2);
- If electricity is generated with biogas from a new anaerobic digester under the project activity: baseline emissions from the generation of electricity in the grid (E2) and / or with a captive fossil fuel fired power plant (E1) in the absence of the electricity generation with biogas.

As a simplification, project participants may neglect one or both emission sources. Baseline emissions from the generation and / or consumption of electricity are calculated as follows:

$$BE_{EL,y} = \left(EC_{BL,y} + EG_{PJ,y}\right) \times EF_{BL,EL,y} \quad (15)$$

Where:

$BE_{EL,y}$	=	CO_2 emissions associated with electricity generation that is displaced by the project activity and / or electricity consumption in the absence of the project activity in year *y* (tCO_2 / yr)
EC_{BL}	=	Annual quantity of electricity that would be consumed in the absence of the project activity for the treatment of the wastewater (scenario 1) or the treatment of the sludge (scenario 2) (MWh / yr)
$EG_{PJ,y}$	=	Net quantity of electricity generated in year *y* with biogas from the new anaerobic biodigester (MWh / yr)
$EF_{BL,EL,y}$	=	Baseline emission factor for electricity generated and / or consumed in the absence of the project activity in year *y* (tCO_2 / MWh)

The determination of $EF_{BL,EL,y}$ depends on the baseline scenario and the configuration at the project site. The grid emission factor should be used ($EF_{BL,EL,y} = EF_{grid,y}$) if the baseline scenario for displacement of electricity generated with biogas from the anaerobic digester is E2 or, in the case that no electricity is generated at the project site, if no captive fossil fuel fired power plant is operating at the project site in year *y*. In all other cases, the lower emission factor between the grid emission factor and the emission factor of the captive power plant should be used as a conservative simplification[5], as follows:

$$EF_{BL,EL,y} = MIN\left(EF_{grid,y}; EF_{BL,EL,captive}\right) \quad \textbf{(16)}$$

Where:

$EF_{BL,EL,y}$	=	Baseline emission factor for electricity generated and / or consumed in the absence of the project activity in year *y* (tCO_2 / MWh)
$EF_{grid,y}$	=	Grid emission factor in year *y* (tCO_2 / MWh)
$EF_{CO2,FF,captive}$	=	CO_2 emission factor of the fossil fuel type used in the captive power plant (tCO_2 / TJ)
$\eta_{captive}$	=	Efficiency of the fossil fuel fired captive power plant

[5] This conservative simplification has been made because it is depends on the exact configuration of the project activity to which extent electricity is displaced in the captive fossil fuel fired power plant and / or the grid. For example:

- The biogas from the digester may be co-fired in an existing captive power plant. The co-firing may partly displace the use of fossil fuels and may partly result in an increased level of electricity generation, thereby displacing grid electricity;
- Under the project activity, a new power plant is installed which displaces an existing captive fossil fuel power plant. In this case, it would be necessary to compare the electricity generation capacity of the new and the existing plant and to determine the remaining technical lifetime of the existing power plant to assess how long and to what extent the continued operation of the existing plant is a reasonable baseline scenario.

Project participants may request for a revision of this methodology to cover their specific project configuration in a more appropriate manner. This may require developing more detailed scenarios (see, for example, ACM0006).

The emission factor of the captive power plant ($EF_{BL,EL,captive}$) may be determined using one of the following options:

- In case of diesel generators: use the value the default emission factor for a diesel generator with a capacity of more than 200 kW for small-scale project activities (0.8 tCO_2 /MWh, see AMS I-D.1 in the simplified baseline and monitoring methodologies for selected small-scale CDM project activity categories);
- Calculate $EF_{BL,EL,captive}$ as follows:

$$EF_{BL,EL,captive} = \frac{EF_{CO2,FF,captive}}{\eta_{EL,captive}} \times 3.6 \qquad \textbf{(17)}$$

Where:

$EF_{BL,EL,y}$	=	Baseline emission factor for electricity generated and / or consumed in the absence of the project activity in year *y* (tCO_2 / MWh)
$EF_{grid,y}$	=	Grid emission factor in year *y* (tCO_2 / MWh)
$EF_{CO2,FF,captive}$	=	CO_2 emission factor of the fossil fuel type used in the captive power plant (tCO_2 / TJ)
$\eta_{EL,captive}$	=	Efficiency of electricity generation of the fossil fuel fired captive power plant

Step 3: Baseline emissions from the generation of heat

This step is applicable if the biogas captured from the new anaerobic digester is utilized in the project scenario for heat generation. If the baseline scenarios H1 or H3 apply, $BE_{HG,y} = 0$.[6] If scenario H2 applies, fossil fuels from the generation of heat in boilers are displaced and baseline emissions are calculated as follows:

$$BE_{HG,y} = \frac{HG_{PJ,y} \times EF_{CO2,FF,boiler}}{\eta_{BL,boiler}} \qquad \textbf{(18)}$$

Where:

$BE_{HG,y}$	=	CO_2 emissions associated with fossil fuel combustion for heating equipment that is displaced by the project in year *y* (tCO_2 / yr)
$HG_{PJ,y}$	=	Net quantity of heat generated in year *y* with biogas from the new anaerobic digester (TJ)
$EF_{CO2,FF,boiler}$	=	CO_2 emission factor of the fossil fuel type used in the boiler for heat generation in the absence of the project activity (tCO_2 / TJ)
$\eta_{BL,boiler}$	=	Efficiency of the boiler that would be used for heat generation in the absence of the project activity

6 In case of cogeneration in the absence of the project activity (H1), the emission reductions from using the biogas in a cogeneration plant are already reflected in Step 2.

Project emissions

Emissions attributed to the project activity depend on which scenario in Table 1 applies and the configuration of the project activity.

(i) Methane emissions from the lagoons or dewatering process (applicable if effluent from the treatment under the project activity is directed to either a lagoon system or to a dewatering facility);

In the case of project activities that introduce an anaerobic digester for the treatment of wastewater or sludge:

(ii) Physical leakage of methane from the digester system;
(iii) Methane emissions from flaring (applicable if biogas from the digester is flared);

In the case of projects that introduce a treatment of sludge:

(iv) Methane and nitrous oxide emissions from land application of sludge (if applicable);

In the case of projects that consume electricity or heat under the project activity:

(v) CO_2 emissions from consumption of electricity and or fossil fuels in the project activity.

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:

$$PE_y = PE_{CH4,effluent,y} + PE_{CH4,digest,y} + PE_{flare,y} + PE_{sludge,LA,y} + PE_{EC,y} + PE_{FC,y} \quad \textbf{(19)}$$

Where:

PE_y	=	Project emissions in year *y* (tCO_2e / yr)
$PE_{CH4,effluent,y}$	=	Project emissions from treatment of wastewater effluent from the anaerobic digester in year *y* (tCO_2e / yr)
$PE_{CH4,digest,y}$	=	Project emissions from physical leakage of methane from the anaerobic digester in year *y* (tCO_2e / yr)
$PE_{flare,y}$	=	Project emissions from flaring of biogas generated in the anaerobic digester in year *y* (tCO_2e / yr)[7]
$PE_{sludge,LA,y}$	=	Project emissions from land application of sludge in year *y* (tCO_2e / yr)
$PE_{EC,y}$	=	Project emissions from electricity consumption in year *y* (tCO_2e / yr)
$PE_{FC,y}$	=	Project emissions from fossil fuel consumption in year *y* (tCO_2e / yr)

[7] The parameters used to determine the project emissions from flaring of the residual gas stream in year *y* should be monitored as per the: "Tool to determine project emissions from flaring gases containing Methane".

(i) Project methane emissions from effluent from the digester

This step is applicable if a new digester is installed under the project activity and if the effluent from this digester is directed to open lagoons or a dewatering facility (see scenario 1 and scenario 2, project activity b in Table 1 of the Applicability conditions).

A significant amount of the COD load is usually degraded in the new anaerobic digester and open lagoons can be expected to operate under largely aerobic conditions. However, due to the uncertainty regarding the exact extent of aerobic / anaerobic degradation after project implementation, the calculation of any CH_4 emissions is conservatively carried out in the same way as for the baseline, using either the methane conversion factor method or the organic removal ratio method. The same method as for the baseline emissions shall be applied.

<u>*Methane conversion factor method*</u>

Project methane emissions from treatment of the effluent from the digester are estimated as follows:

$$PE_{CH4,effluent,y} = GWP_{CH4} \times MCF_{PJ,y} \times B_o \times \left(COD_{PJ,effl,dig,y} - COD_{PJ,effl,lag,y}\right) \quad \text{with} \tag{20}$$

$$COD_{PJ,effl,dig,y} = \sum_{m=1}^{12} F_{PJ,effl,dig,m} \times w_{COD,effl,dig,m} \quad \text{and} \tag{21}$$

$$COD_{PJ,effl,lag,y} = \sum_{m=1}^{12} F_{PJ,effl,lag,m} \times w_{COD,effl,lag,m} \tag{22}$$

Where:

$PE_{CH4,effluent,y}$	=	Project emissions from treatment of wastewater effluent from the anaerobic digester in year *y* (tCO_2e / yr)
GWP_{CH4}	=	Global Warming Potential of methane valid for the commitment period (tCO_2e / tCH_4)
$MCF_{PJ,y}$	=	Project methane conversion factor (fraction) in year *y*, representing the fraction of ($COD_{PJ,effluent,y}$ x B_o) that degradeds to CH_4
B_o	=	Maximum methane producing capacity, expressing the maximum amount of CH_4 that can be produced from a given quantity of chemical oxygen demand (tCH_4 / tCOD)
$COD_{PJ,effl,dig,y}$	=	Quantity of chemical oxygen demand in the effluent from the digester in year *y* (tCOD / yr)
$COD_{PJ,effl,lag,y}$	=	Quantity of chemical oxygen demand in the effluent of the open lagoon or dewatering facility in which the effluent from the digester is treated in year *y* (tCOD / yr)
$F_{PJ,effl,dig,m}$	=	Quantity of effluent from the digester in month *m* (m^3 / month)
$w_{COD,effl,dig,m}$	=	Average chemical oxygen demand in the effluent from the digester in month *m* (t COD / m^3)
$F_{PJ,effl,lag,m}$	=	Quantity of effluent from the open lagoon or dewatering facility in which the effluent from the digester is treated in month *m* (m^3 / month)
$w_{COD,effl,lag,m}$	=	Average chemical oxygen demand in the effluent from the open lagoon or dewatering facility in which the effluent from the digester is treated in month *m* (t COD / m^3)

The quantity of methane generated from COD disposed to the open lagoon or in dewatering facility is calculated as follows:

$$MCF_{PJ,y} = f_d \times f_{PJ,T,y} \quad \textbf{(23)}$$

Where:

$MCF_{PJ,y}$	=	Project methane conversion factor (fraction) in year *y*, representing the fraction of ($COD_{PJ,effluent,y}$ x B_o) that degrades to CH_4
f_d	=	Factor expressing the influence of the depth of the lagoon or dewatering facility on methane generation
$f_{PJ,T,y}$	=	Factor expression the influence of the temperature on the methane generation under the project activity in year *y*

The factor $f_{T,PJ,y}$ is calculated, as under baseline emissions, with the help of a monthly stock change model which aims at assessing how much COD degrades in each month, as follows:

$$COD_{PJ,available,m} = \left(COD_{PJ,effl,dig,m} - COD_{PJ,effl,lag,m}\right) + (1 - f_{T,m}) \times COD_{PJ,available,m-1} \quad \text{with} \quad \textbf{(24)}$$

$$COD_{PJ,effl,dig,m} = F_{PJ,effl,dig,m} \times w_{COD,effl,dig,m} \quad \text{and} \quad \textbf{(25)}$$

$$COD_{PJ,effl,lag,m} = F_{PJ,effl,lag,m} \times w_{COD,effl,lag,m} \quad \textbf{(26)}$$

Where:

$COD_{PJ,available,m}$	=	Quantity of chemical oxygen demand available for degradation in the open lagoon or dewatering facility under the project activity in month *m* (t COD / month)
$COD_{PJ,effl,dig,m}$	=	Quantity of chemical oxygen demand in the effluent from the digester in month *m* (tCOD / month)
$COD_{PJ,effl,lag,m}$	=	Quantity of chemical oxygen demand in the effluent of the open lagoon or dewatering facility in which the effluent from the digester is treated in month *m* (tCOD / month)
$F_{PJ,effl,dig,m}$	=	Quantity of effluent from the digester in month *m* (m^3 / month)
$w_{COD,effl,dig,m}$	=	Average chemical oxygen demand in the effluent from the digester in month *m* (t COD / m^3)
$F_{PJ,effl,lag,m}$	=	Quantity of effluent from the open lagoon or dewatering facility in which the effluent from the digester is treated in month *m* (m^3 / month)
$w_{COD,effl,lag,m}$	=	Average chemical oxygen demand in the effluent from the open lagoon or dewatering facility in which the effluent from the digester is treated in month *m* (t COD / m^3)
$f_{T,m}$	=	Factor expressing the influence of the temperature on the methane generation in month *m*
m	=	Months of year *y* of the crediting period

As for the baseline emissions, the carry-over calculations are limited to a maximum of one year. In case the residence time in the open lagoon or the dewatering facility is less than one year, carry-on calculations are limited to the period where the wastewater remains in the lagoon or dewatering facility. Project participants should provide evidence of the typical residence time of the organic matter in the lagoon or the dewatering facility.

The monthly factor to account for the influence of the temperature on methane generation is calculated as per equation (10) above.

Based on the monthly values $f_{T,m}$ the annual value $f_{T,PJ,y}$ is calculated as follows:

$$f_{PJ,T,y} = \frac{\sum_{m=1}^{12} f_{T,m} \times COD_{PJ,avaialble,m}}{\sum_{m=1}^{12} \left(COD_{PJ,effl,dig,m} - COD_{PJ,effl,lag,m} \right)} \quad \textbf{(27)}$$

Where:

$f_{PJ,T,y}$	=	Factor expressing the influence of the temperature on the methane generation under the project activity in year *y*
$f_{T,m}$	=	Factor expressing the influence of the temperature on the methane generation in month *m*
$COD_{PJ,available,m}$	=	Quantity of chemical oxygen demand available for degradation in the open lagoon or dewatering facility under the project activity in month *m* (t COD / month)
$COD_{PJ,effl,dig,m}$	=	Quantity of chemical oxygen demand in the effluent from the digester in month *m* (tCOD / month)
$COD_{PJ,effl,lag,m}$	=	Quantity of chemical oxygen demand in the effluent of the open lagoon or dewatering facility in which the effluent from the digester is treated in month *m* (tCOD / month)
m	=	Months of year *y* of the crediting period

Organic removal ratio method

As for baseline emissions, methane emissions from anaerobic treatment of the effluent from the digester are estimated based on a mass balance of the organic matter, as follows:

$$PE_{CH4,effluent,y} = GWP_{CH4} \times B_o \times \left(COD_{PJ,effl,dig,y} - COD_{PJ,aerobic} - COD_{PJ,OX,y} - COD_{PJ,sedim,y} - COD_{PJ,effl,lag,y} \right) \quad \textbf{(28)}$$

Where:

$PE_{CH4,effluent,y}$	=	Project emissions from treatment of wastewater effluent from the anaerobic digester in year *y* (tCO_2e / yr)
GWP_{CH4}	=	Global Warming Potential of methane valid for the commitment period (tCO_2e / tCH_4)
B_o	=	Maximum methane producing capacity, expressing the maximum amount of CH_4 that can be produced from a given quantity of chemical oxygen demand (tCH_4 / tCOD)
$COD_{PJ,effl,dig,y}$	=	Quantity of chemical oxygen demand in the effluent from the digester in year *y* (t COD / yr)
$COD_{PJ,aerobic}$	=	Annual quantity of chemical oxygen demand that degrades aerobically in the lagoon or

		sludge pit under the project activity (t COD / yr)
$COD_{PJ,OX,y}$	=	Annual quantity of chemical oxygen demand that is chemically oxidised through oxidizing substances in the effluent from the digester in year *y* (t COD / yr)
$COD_{PJ,sedim,y}$	=	Amount of chemical oxygen demand lost through sedimentation in the lagoon or sludge pit under the project activity (t COD / yr)
$COD_{PJ,effl,lag,}$	=	Quantity of chemical oxygen demand in the effluent of the open lagoon or dewatering facility in which the effluent from the digester is treated in year *y* (t COD / yr)

$COD_{PJ,effl,dig,y}$ and $COD_{PJ,effl,lag,y}$ are determined as per equations (21) and (22) for the methane conversion factor method. $COD_{PJ,aerobic}$ is determined as per equation (13) under baseline emissions. To determine $COD_{sedim,PJ,y}$ the procedure in Appendix II shall be applied. $COD_{PJ,OX,y}$ is determined, as under baseline emissions, as follows:

$$COD_{PJ,OX,y} = \sum_{m}^{12} F_{PJ,effl,dig,m} \times \sum_{s} w_{s,effl,y} \times R_s \times 0.001 \quad \textbf{(29)}$$

Where:

$COD_{PJ,OX,y}$	=	Annual quantity of chemical oxygen demand that is chemically oxidised through oxidizing substances in the effluent from the digester in year *y* (t COD / yr)
$F_{PJ,effl,dig,m}$	=	Quantity of effluent from the digester in month *m* (m^3 / month)
$w_{s,effl,y}$	=	Average concentration of chemical oxidative substance *s* in the effluent from the digester in year *y* (kg / m^3)
R_s	=	Specific reduction in chemical oxygen demand by substance *s* (t COD / t substance)
s	=	Substances in the effluent of the digester that can chemically oxidize organic matter

(ii) Project emissions related to physical leakage from the digester

This step is applicable if the project activity includes the construction of a new anaerobic digester. The emissions directly associated with the operation of digesters involve the physical leakage of methane from the digester system. Methane emissions from the new digester are calculated as follows:

$$PE_{CH4,digest,y} = F_{biogas,y} \times FL_{biogas,digest} \times w_{CH4,biogas,y} \times GWP_{CH4} \times 0.001 \quad \textbf{(30)}$$

Where:

$PE_{CH4,digest,y}$	=	Project emissions from physical leakage of methane from the anaerobic digester (tCO_2e / yr)
$F_{biogas,y}$	=	Amount of biogas collected in the outlet of the new digester in year *y* (m^3/ yr)
$FL_{biogas,digest}$	=	Fraction of biogas that leaks from the digester (m^3 biogas leaked / m^3 biogas produced)
$w_{CH4,biogas,y}$	=	Concentration of methane in the biogas in the outlet of the new digester (kg CH_4 / m^3)
GWP_{CH4}	=	Global Warming Potential of methane valid for the commitment period (tCO_2e / tCH_4)

(iii) Methane emissions from flaring

This step is applicable if under the project activity biogas is generated in a new anaerobic digester and if all or a part of the biogas is flared. Methane may be released as a result of incomplete combustion in the flare. To calculate project emissions from flaring of the biogas (PE_{flare}) apply the latest approved version of the "Tool to determine project emissions from flaring gases containing methane".

(iv) Project emissions from land application of sludge

This step is 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 equation:

$$\mathrm{PE}_{\mathrm{sludge,LA,y}} = COD_{sludge,LA,y} \times B_o \times MCF_{sludge,LA} \times GWP_{CH4} + S_{LA,y} \times w_{N,sludge,y} \times EF_{N2O,LA,sludge} \times \mathrm{GWP}_{\mathrm{N2O}} \qquad \textbf{(31)}$$

Where:

$PE_{sludge,LA,y}$	=	Project emissions from land application of sludge in year y (tCO_2e / yr)
$COD_{sludge,LA,y}$	=	Chemical oxygen demand (COD) of the sludge applied to land after the dewatering process in year y (tCOD / yr)
$MCF_{sludge,LA}$	=	Methane conversion factor for the application of sludge to lands
GWP_{CH4}	=	Global Warming Potential of methane valid for the applicable commitment period (tCO_2e / tCH_4)
$S_{LA,y}$	=	Amount of sludge applied to land in year y (t / yr)
$w_{N,sludge,y}$	=	Mass fraction of nitrogen in the sludge applied to land in year y (t N / t sludge)
$EF_{N2O,LA,sludge}$	=	N_2O emission factor for nitrogen from sludge applied to land (t N_2O / t N)
GWP_{N2O}	=	Global Warming Potential of nitrous dioxide (tCO_2e / tN_2O)

(v) Project emissions from electricity consumption and combustion of fossil fuels in the project

This emission source includes CO_2 emissions from the consumption of electricity or combustion of fossil fuels for the operation of the project activity. This may, for example, include the operation of pumps or the combustion of fossil fuels for the heat generation.

If electricity is generated with biogas under the project activity, the electricity consumption for the operation of the project activity should be subtracted from the total on-site electricity generation with biogas in calculating $EG_{PJ,y}$ (i.e. $EG_{PJ,y}$ only includes the *net* electricity generation resulting from the project activity). Otherwise, the latest approved version of the "Tool to calculate project emissions from electricity consumption" should be applied to calculate project emissions from electricity consumption ($PE_{EC,y}$).

If fossil fuels are combusted for the purpose of the project activity, CO_2 emission from fossil fuel combustion ($PE_{FC,y}$) should be calculated using the latest approved version of the "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion".

Leakage

No leakage is estimated.

Emission Reductions

Emission reductions for any given year of the crediting period are obtained by subtracting project emissions from baseline emissions:

$$ER_y = BE_y - PE_y \tag{32}$$

Where:

ER_y	=	Emissions reductions of the project activity in year *y* (tCO_2e / year)
BE_y	=	Baseline emissions in year *y* (tCO_2e / year)
PE_y	=	Project emissions in year *y* (tCO_2e / year)

Changes required for methodology implementation in 2nd and 3rd crediting periods

Consistent with guidance by the Executive Board, project participants shall assess the continued validity of the identified baseline scenarios and update the baseline parameters.

Data and parameters not monitored

In addition to the data and parameters listed below, the guidance on “data and parameters not monitored” in all tools to which this methodology refers applies.

Parameter:	− $COD_{out,x}$ − $COD_{in,x}$
Data unit:	ton COD / unit of time (year, month)
Description:	− COD of the effluent in the period x − COD directed to the open lagoons (scenario 1) or in sludge pits (scenario 2) in the period x
Source of data:	For existing plants: one year of historical data. If no data is available the COD inflow to and effluent from the lagoon or sludge pit during a measurement campaign of at least 10 days. For Greenfield projects: use the design COD inflow for COD in and the design effluent COD flow for COD out corresponding to the design features of the lagoon system identified in the procedure for the selection of the baseline scenario.
Measurement procedures (if any):	The measurements should be undertaken during a period that is representative for the typical operation conditions of the plant and ambient conditions of the site (temperature, etc). The average COD_{in} and COD_{out} values from the measurement campaign shall be used in equation (4) and the result shall be multiplied by 0.89 to account for the uncertainty range (of 30% to 50%) associated with this approach as compared to one-year historical data.
Any comment:	x = Representative historical reference period (at least one year)

Parameter:	**B_o**
Data unit:	tCH_4 / tCOD
Description:	Maximum methane producing capacity, expressing the maximum amount of CH_4 that can be produced from a given quantity of chemical oxygen demand (COD)
Source of data:	2006 IPCC Guidelines
Measurement procedures (if any):	No measurement procedures. The default IPCC value for B_o is 0.25 kg CH_4 / kg COD. If the methodology is used for wastewater containing materials not akin to simple sugars, a CH_4 emissions factor different from 0.21 tCH_4 / tCOD has to be estimated and applied.
Any comment:	Taking into account the uncertainty of this estimate, project participants should use a value of 0.21 kg CH_4 / kg COD as a conservative assumption for B_o

Parameter:	f_d
Data unit:	-
Description:	Factor expressing the influence of the depth of the lagoon or sludge pit on methane generation
Source of data:	Apply the following values for the corresponding average depth of the open lagoon or the sludge pit: Depth > 5 m: 70% Depth 1 – 5 m: 50% Depth < 1 m: 0%
Measurement procedures (if any):	-
Any comment:	Applicable to the methane conversion factor method. In the case of ~~Greenfield~~ projects activities 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”.

Parameter:	$\mathbf{f_{COD,aerobic}}$
Data unit:	t COD / ha yr
Description:	Quantity of chemical oxygen demand degraded to CO_2 under aerobic conditions per surface area of the lagoon or sludge pit
Source of data:	Experiments have to be conducted
Measurement procedures (if any):	Suggested value: 92.7 t COD / ha yr (= 254 kg COD / ha day)
Any comment:	Applicable to the organic removal ratio method

Parameter:	**D**
Data unit:	m
Description:	Average depth of the lagoon or sludge pit
Source of data:	For existing plants: Conduct measurements For project activities implemented in Greenfield facilities ~~Greenfield plants~~: 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”
Measurement procedures (if any):	Determine the average depths of the whole lagoon / sludge pit under normal operating conditions
Any comment:	

Parameter:	**EC_{BL}**
Data unit:	MWh / yr
Description:	Annual quantity of electricity that would be consumed in the absence of the project activity for the treatment of the wastewater (scenario 1) or the treatment of the sludge (scenario 2)
Source of data:	- In case of existing plants: Historical records of the average electricity during the most recent three years prior to the implementation of the project activity - In case of project activities implemented in Greenfield facilities~~plants~~: According to the baseline lagoon design as identified in step 1 of the section "Procedure for the identification of the most plausible baseline scenario"
Measurement procedures (if any):	Historical records must correspond to measurements whereby electricity meters undergo maintenance / calibration subject to appropriate industry standards. The accuracy of the meter readings will be verified by receipts issued by the purchasing power company. Uncertainty of the meters to be obtained from the manufacturers.
Any comment:	

Parameter:	– $EF_{grid,y}$ – $EF_{BL,EL,y}$
Data unit:	tCO_2 / MWh
Description:	– Grid emission factor in year *y* – Baseline emission factor for electricity generated and / or consumed in the absence of the project activity in year *y* (tCO_2 / MWh)
Source of data:	Calculated in accordance with the latest approved version of the "Tool to calculate the emission factor for an electricity system"
Measurement procedures (if any):	----
Any comment:	----

Parameter:	– $EF_{CO2,FF,captive}$ – $EF_{CO2,FF,boiler}$
Data unit:	tCO2 / TJ
Description:	– CO_2 emission factor of the fossil fuel type used in the captive power plant – CO_2 emission factor of the fossil fuel type used in the boiler for heat generation in the absence of the project activity
Source of data:	Actual measured or local data is to be used. If not available, regional data should be used and, in its absence, IPCC defaults can be used from the most recent version of IPCC Guidelines for National Greenhouse Gas Inventories.
Measurement procedures (if any):	----
Any comment:	If the measurement results differ significantly from previous measurements or other relevant data sources, conduct additional measurements. Double-checked against IPCC defaults (for consistency) if data is local or regional.

Parameter:	– $\eta_{EL,captive}$ – $\eta_{BL,boiler}$
Data unit:	%
Description:	– Efficiency of the fossil fuel fired captive power plant – Efficiency of the boiler that would be used for heat generation in the absence of the project activity
Source of data:	
Measurement procedures (if any):	Depending on which option is chosen, the source will be either of the following: • Measured efficiency prior to project implementation; • Measured efficiency during monitoring; • Manufacturer nameplate data for efficiency of the existing equipment.
Any comment:	

Parameter:	$\mathbf{EF_{CH4,digest,y}}$
Data unit:	m³ biogas leaked / m³ biogas produced
Description:	Fraction of biogas that leaks from the digester
Source of data:	Either use a default value of 0.15 (based on the 2006) IPCC guidelines or undertake measurements
Measurement procedures (if any):	----
Any comment:	Applicable if a new digester is installed under the project activity

Parameter:	$\mathbf{EF_{N2O,LA,sludge}}$
Data unit:	t N_2O / t N
Description:	Emission factor of nitrogen from sludge applied to land to be assumed
Source of data:	Stehfest, E. and Bouwman, A.F. N_2O 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_2O-N / kg N (= 0.016 kg N_2O / kg N).
Measurement procedures (if any):	No measurement procedures. Value to be applied: 0.016
Any comment:	Applicable if sludge is applied on lands under the project activity

Parameter:	$\mathbf{MCF_{sludge,la}}$
Data unit:	--------
Description:	Methane conversion factor for sludge used for land application
Source of data:	
Measurement procedures (if any):	No measurement procedures. Value to be applied 0.05
Any comment:	

Parameter:	**GWP_{CH4}**
Data unit:	tCO_2e / tCH_4
Description:	Global warming potential for CH_4
Source of data:	IPCC
Measurement procedures (if any):	Default to be applied: 21 for the first commitment period.
Any comment:	Shall be updated according to any future COP/MOP decisions

Parameter:	**GWP_{N2O}**
Data unit:	tCO_2e / tN_2O
Description:	Global warming potential for N_2O
Source of data:	IPCC
Measurement procedures (if any):	Default to be applied: 296 for the first commitment period
Any comment:	Shall be updated according to any future COP/MOP decisions

Parameter:	**Rs**
Data unit:	t COD / t substance
Description:	Specific reduction in chemical oxygen demand by substance *s*
Source of data:	The most conservative default value from review of published literature
Measurement procedures (if any):	
Any comment:	Substance is very likely to be SO4

Parameter:	**A**
Data unit:	Unit of area (ha)
Description:	Surface of the lagoon or sludge pit
Source of data:	Actual measurements in case of existing lagoons. In case of project activities implemented in Greenfield facilitiesplants: According to the baseline lagoon design as identified in step 1 of the section "Procedure for the identification of the most plausible baseline scenario"
Measurement procedures (if any):	
Any comment:	

III. MONITORING METHODOLOGY

Monitoring procedures

The monitoring methodology is schematically represented in the diagram contained in Annex III, showing the flows between the different parts of the project. Note: after the modifications the diagram (originally presented in AM0014) was no longer representative and therefore it has been was removed.

The parameters used to determine the project emissions from flaring of the residual gas stream in year *y* should be monitored as per the: "Tool to determine project emissions from flaring gases containing Methane".

Similarly, for parameters to be monitored for the calculation of project emissions related to the consumption of electricity and heat please refer to the latest approved version of:

"Tool to calculate project emissions from electricity consumption"

"Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion"

Data and parameters monitored

Parameters used for determination of baseline emissions

Data / Parameter:	$F_{PJ,dig,m}$
Data unit:	m^3 / month
Description:	Quantity of wastewater or sludge that is treated in the anaerobic digester or under clearly aerobic conditions in the project activity in month *m*
Source of data:	Measured
Measurement procedures (if any):	
Monitoring frequency:	Parameter monitored continuously but aggregated annually for calculations
QA/QC procedures:	
Any comment:	

Data / Parameter:	$w_{COD,dig,m}$
Data unit:	t COD / m³
Description:	Average chemical oxygen demand in the wastewater or sludge that is treated in the anaerobic digester or under clearly aerobic conditions in the project activity in month *m*
Source of data:	Measurements
Measurement procedures (if any):	Measure the COD according to national or international standards
Monitoring frequency:	Regularly, calculate average monthly and annual values
QA/QC procedures:	
Any comment:	

Data / Parameter:	$w_{S,y}$
Data unit:	~~t COD~~ Kg / m³
Description:	Average concentration of chemical oxidative substance s in the wastewater or sludge treated in the digester in year *y*
Source of data:	Measurements
Measurement procedures (if any):	Measure the COD according to national or international standards
Monitoring frequency:	Regularly, calculate average monthly and annual values
QA/QC procedures:	
Any comment:	Organic removal ratio (baseline emissions)

Data / Parameter:	$T_{2,m}$
Data unit:	K
Description:	Average temperature at the project site in month *m*
Source of data:	National or regional weather statistics
Measurement procedures (if any):	-
Monitoring frequency:	Continuously, aggregated in monthly average values
QA/QC procedures:	-
Any comment:	Applicable for the methane conversion factor method

Data / Parameter:	$EG_{PJ,y}$
Data unit:	MWh / year
Description:	Net quantity of electricity generated in year *y* with biogas from the new anaerobic
Source of data:	Measurements
Measurement procedures (if any):	
Monitoring frequency:	Monitored daily
QA/QC procedures:	
Any comment:	

Data / Parameter:	$HG_{PJ,y}$
Data unit:	TJ / year
Description:	Net quantity of heat generated in year *y* with biogas from the new anaerobic digester
Source of data:	Measured from the heat received by the heated process; else Calculated on the basis if measurement of the volume of biogas captured and used for heat generation multiplied by the methane content of the gas, CV methane, and the efficiency of the boiler during the project (i.e. with biogas)
Measurement procedures (if any):	
Monitoring frequency:	Monitored daily
QA/QC procedures:	
Any comment:	

Data / Parameter:	– $F_{PJ,effl,dig,m}$ – $F_{PJ,effl,lag,m}$ – $S_{LA,y}$
Data unit:	m³ / month
Description:	– Quantity of effluent from the digester in month *m* – Quantity of effluent from the open lagoon or dewatering facility in which the effluent from the digester is treated in month *m* – Quantity of sludge applied to land in year
Source of data:	Measured
Measurement procedures (if any):	
Monitoring frequency:	Parameter monitored continuously but aggregated annually for calculations
QA/QC procedures:	
Any comment:	*y* = Year of the project activity *m* = Months of year *y* of the crediting period Note: annual values are derived from the monthly measures (m)

Data / Parameter:	– $w_{COD,effl,dig,m}$ – $w_{COD,effl,lag,m}$
Data unit:	t COD / m³
Description:	– Average chemical oxygen demand in the effluent from the digester in month *m* – Average chemical oxygen demand in the effluent from the open lagoon or dewatering facility in which the effluent from the digester is treated in month *m*
Source of data:	Measurements
Measurement procedures (if any):	Measure the COD according to national or international standards
Monitoring frequency:	Regularly, calculate average monthly and annual values
QA/QC procedures:	
Any comment:	

Data / Parameter:	$w_{S,effl,y}$
Data unit:	Kg / m³
Description:	Average concentration of chemical oxidative substance *s* in the effluent from the digester in year *y*
Source of data:	Measurements
Measurement procedures (if any):	Measure according to national or international standards
Monitoring frequency:	Regularly, calculate average monthly and annual values
QA/QC procedures:	
Any comment:	Organic removal ratio method

Data / Parameter:	$w_{N,sludge,y}$
Data unit:	t N / t sludge
Description:	Mass fraction of nitrogen in the sludge applied to land in year *y*
Source of data:	Measurements
Measurement procedures (if any):	Measured according to national or international standards
Monitoring frequency:	Regularly, calculate average monthly and annual values
QA/QC procedures:	
Any comment:	

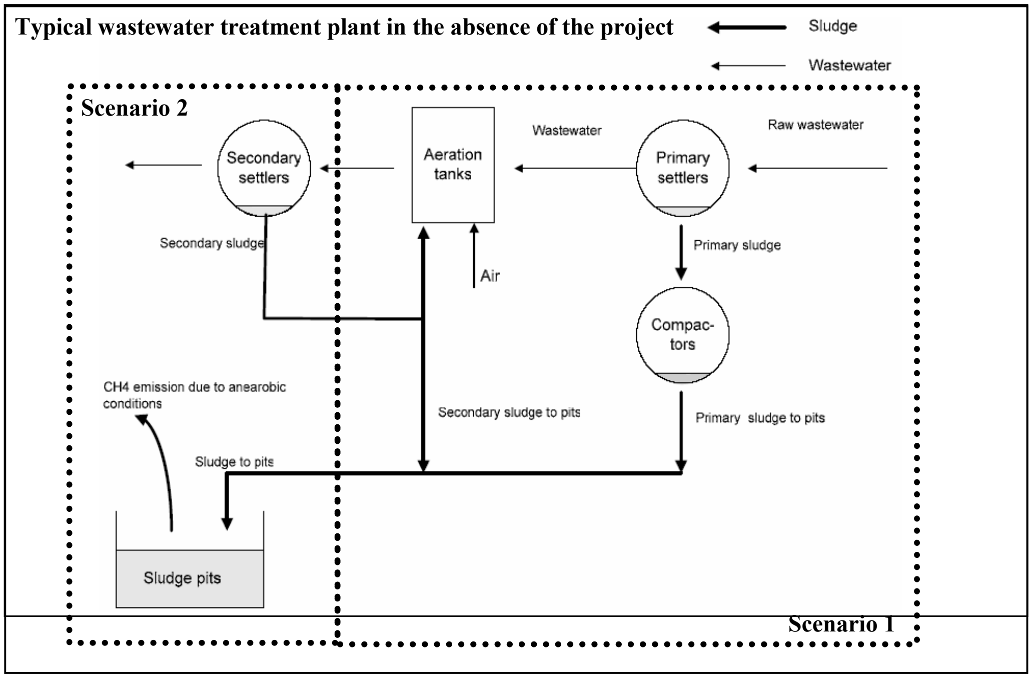
Data / Parameter:	$F_{biogas,y}$
Data unit:	m^3 / yr
Description:	Amount of biogas collected in the outlet of the new digester in year *y*
Source of data:	Measured
Measurement procedures (if any):	
Monitoring frequency:	Parameter monitored continuously but aggregated annually for calculations
QA/QC procedures:	Flow meters will undergo maintenance / calibration subject to appropriate industry standards. The frequency of calibration and control procedures would be different for each application. This maintenance / calibration practice should be clearly stated in the CDM-PDD.
Any comment:	Applied to estimate emissions associated with physical leakage from the digester

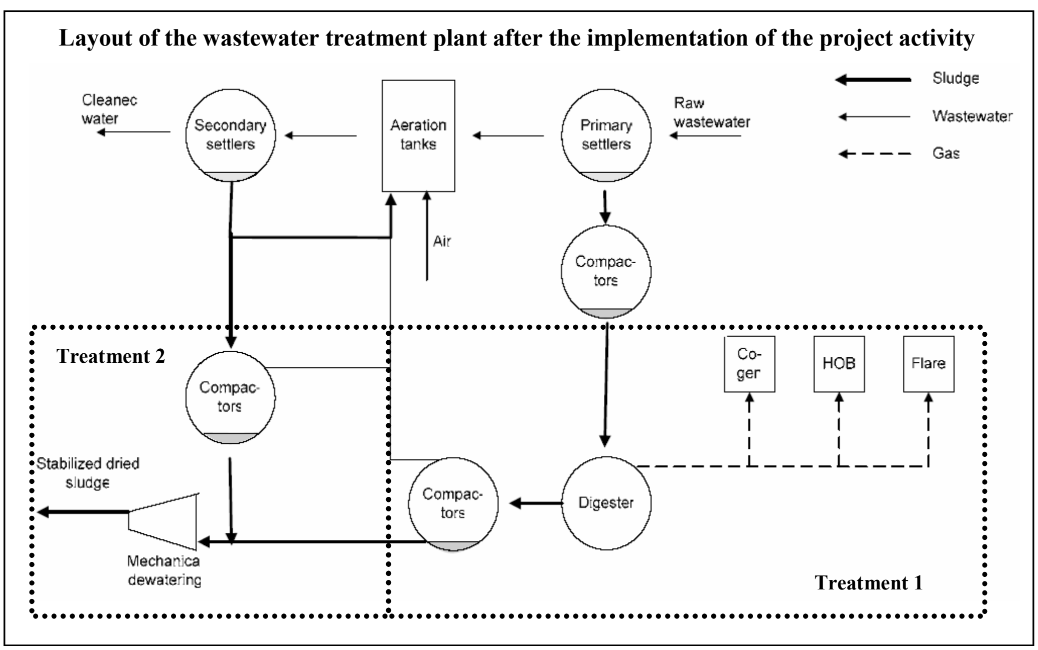
Data / Parameter:	$FL_{biogas,digest,y}$
Data unit:	m³ biogas leaked / m³ biogas produced
Description:	Fraction of biogas that leaks from the digester
Source of data:	Measured
Measurement procedures (if any):	Using calibrated portable gas meters. To be measured at wet basis
Monitoring frequency:	Either with continuous analyzer or alternatively with periodical measurement at 95% confidence level
QA/QC procedures:	The project proponents shall define the variability of the concentration. They shall also define the error in estimate for different level of measurement frequency. The level of accuracy will be deducted from average concentration of measurement.
Any comment:	Applied to estimate emissions associated with physical leakage from the digester

Data / Parameter:	$w_{CH4,biogas,y}$
Data unit:	kg CH_4 / m³
Description:	Concentration of methane in the biogas in the outlet of the new digester
Source of data:	Measured
Measurement procedures (if any):	Using calibrated continuous gas analyser
Monitoring frequency:	Either with continuous analyser or alternatively with periodical measurement at 95% confidence level
QA/QC procedures:	The project proponents shall define the error for different levels of measurement frequency. The level of accuracy will be deducted from average concentration of measurement.
Any comment:	

Data / Parameter:	$COD_{,PJ,sedim,y}$
Data unit:	t COD / yr
Description:	Amount of chemical oxygen demand lost through sedimentation in the lagoon or sludge pit under the project activity
Source of data:	Measurements
Measurement procedures (if any):	Sampling procedures described in Annex II
Monitoring frequency:	
QA/QC procedures:	
Any comment:	

APPENDIX I: Illustration of the project activity and the historical situation





APPENDIX II : Determining rates of sedimentation

To estimate the amount of Chemical Oxygen Demand that is lost through sedimentation, the first step is to characterise the type of organic waste material in order to determine the likelihood of any sedimentation actually taking place. In addition, the conditions in the existing lagoon system must also be assessed to determine the lagoon dynamics in relation to mixing. Those lagoons so identified as highly anaerobically active have the characteristic to keep all the material that would sediment in a state of permanent suspension, this material is then anaerobically degraded. Where such characteristics of sedimentation are identified, the fraction of Chemical Oxygen Demand lost to sedimentation is determined by monitoring the rate of COD entering the pond system and the rate at which pond depth alters over time. Then, a relationship between pond depth and sedimentation can be established.

Pond Based Sedimentation Determination

Daily pond sedimentation rates vary in a seasonally operated industry. There are no hard average numbers for the dynamic deposition rate to be expected. Project proponents should determine whether the wastewater contains material that is likely to sediment, and assess whether the pond dynamics are such that such sedimentation will occur. Where these conditions occur, an analysis must be carried out as to the rate of this sedimentation. Having verified these conditions, project proponents should measure the net annual effect of the COD deposition into the sediment of individual ponds at long time intervals because the pond sediment sludge amount accumulates gradually over the years. This is often shown by the historic evidence of gradually shrinking working volumes of the treatment pond(s) in question.

Approach to determine the net annual COD sedimentation in wastewater treatment ponds

A GPS grid of at least 20 sampling points / pond will be put over each pond that is monitored. The distance of the GPS points from the pond bank needs to be at least 2 m. Twice a year (start of season and end of season) the following protocol will be performed:

(a) At each sampling time, determine pond water level height at all four corners of the pond by theodolite against an absolute height reference, ideally a concrete wall (accuracy > + / - 5 mm);
(b) Using an immersible turbidimeter mounted on a calibrated depth probe chain measure the sediment surface height relative to the water surface at the points indicated by the GPS grid.

Note: Gas masks / face shields need to be worn for this task due to the risk of H_2S poisoning and high temperatures. There is also a high fire risk on the pond surface. Thus under no circumstances can flammable items, cellphones or other equipment that could trigger a spark be brought onto the pond surface. This instruction must be obeyed at all times.

With a rowing boat determine at each GPS point the relative pond water column depth relative to the absolute height reference determined under (a). Calculate the relative increase / decrease in the average sediment height of the pond system twice / year, i.e. at the beginning and the end of a season determining the change in between seasons by calculation.

(c) Obtain a 10 cm diam x 40 cm core of the sediment layer at each GPS point with a core sampler (4 " plastic pipe). Combine the 0-20 cm layer cores and the 20-40 cm layer cores for all 20 points into a large drum. Mix the combined 0-20 cm (fraction A) and 20-40 cm samples (fraction B) with a metal or plastic rod. Take four random sub-samples of each of the two combined samples to determine VSS, TSS and COD. Carry out the sediment composition analysis in an experienced laboratory such as Waste Solutions Ltd, Analytical Laboratory.

(d) Calculate the mean+ / - SD for COD, VSS, TSS of each group. Perform a test of statistical significance of any observed changes (t-test, paired) by comparing the paired pre-season / pre-season and paired post-season / post-season samples for two consecutive years. Any real COD accumulation / deposition trend (if real) must be visible in the paired pre-season / pre-season and paired post-season / post-season time points. The net COD deposition relative for the methane abatement balance in a season is determined by comparing the net sediment mass (COD, VSS, TSS) in the pond at the beginning of a new season with the previously measured pre-existing net deposition at the beginning of the previous season. It is assumed that the net sediment COD deposition by sedimentation in a steady state situation has the composition of the sediment material of the B-fraction because the B-fraction is the actual accumulating stable end product in the pond sediment.

(e) The amount of accumulated sediment COD / pond deposited every year is then determined as follows.

- Determine B-fraction COD content (g COD / g sediment; wet basis)
- Calculate the net accumulated COD in pond (Mg / pond / year) as:

Accumulated COD = [area (m2) x increase (m / year)] x sediment density x COD content B-fraction (gCOD / gwet)

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History of the document

Version	Date	Nature of revision(s)
02	EB 38, Annex 5 14 March 2008	1. To extend applicability to include product activities implementation in Greenfield facilities 2. Editorial corrections on the basis of quality check by the secretariat and a request for clarification
01	EB 36, Annex 14 30 November 2007	Initial adoption