Approved baseline and monitoring methodology AM0080

"Mitigation of greenhouse gases emissions with treatment of wastewater in aerobic wastewater treatment plants"

I. SOURCE, DEFINITIONS AND APPLICABILITY

Sources

This methodology is based on the following submission:

- NM0250: Fès Waste Water Treatment Plant (WWTP) with sludge treatment and biogas recovery & utilization for electricity generation at Fès city, Morocco.

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

- "Combined tool to identify the baseline scenario and demonstrate additionality";
- "Tool to determine project emissions from flaring gases containing methane";
- "Tool to calculate the emission factor for an electricity system";
- "Tool to calculate baseline, project and/or leakage emissions from electricity consumption";
- "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion".

For more information regarding the proposed new methodologies and the tools as well as their consideration by the Executive Board please refer to <http://cdm.unfccc.int/goto/MPappmeth>.

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:

Anaerobic digester. In 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.

Aerobic wastewater treatment plant. Wastewater treatment plant that operates under mainly aerobic conditions, based on the activated sludge process. The activated sludge process comprises primary and secondary treatment stages. The primary treatment includes screening, grit chamber and primary sedimentation tank, and the secondary treatment is based on the recirculation of activated sludge. The secondary treatment is where the substantial degradation of the biological content takes place. A diagram of the plant is presented in Annex 1.

Anaerobic open lagoons system. System of lagoons and ponds where wastewater is treated by a complex of bacteria under mainly anaerobic conditions.

Applicability

This methodology is applicable to project activities that implement a new aerobic wastewater treatment plant for the treatment of domestic and/or industrial wastewater. The sludge produced in the aerobic wastewater treatment plant in the project activity is either:

(1) Treated in the same way as the sludge that would have been produced in the anaerobic open lagoons system in the baseline scenario would have been treated. This includes one of the following two options: (i) the sludge is dumped or left to decay; or (ii) the sludge is dried under controlled and aerobic conditions, and then disposed to a landfill with methane recovery or used in soil application; or

(2) Treated in a new anaerobic digester, with the biogas extracted from the anaerobic digester being flared and/or used to generate electricity and/or heat. The residues from the anaerobic digester are dehydrated, limed and stored before final disposal in a controlled landfill.

Project participants should document in the CDM-PDD their specific case and clearly describe (a) the situation before the implementation of the project activity, (b) the situation under the project activity and (c) the situation in the baseline scenario, by providing diagrams.

The following conditions apply:

- The project activity either replaces an existing anaerobic open lagoons system, with or without conversion of the sludge treatment system, or is an alternative to a new to be built anaerobic open lagoons system;
- Loading in the wastewater streams has to be high enough to ensure that the existing or new to be built anaerobic open lagoons system develops an anaerobic bottom layer and that algal oxygen production can be ruled out;
- The average depth of the existing or new to be built anaerobic open lagoons system is at least 1 meter. In case of an existing anaerobic open lagoons system in the baseline scenario, the depth of the lagoons should be verified based on historical data available for one year before the implementation of the project activity. In case of a new to be built anaerobic open lagoons system, the depth of the lagoons should be determined following the guidance provided in Step 1 of the section "Procedure for the identification of the most plausible baseline scenario and assessment of additionality";
- The residence time of the organic matter in the anaerobic open lagoons system is at least 30 days. In case of an existing anaerobic open lagoons system in the baseline scenario, the residence time of the organic matter in the lagoon should be verified based on historical data available for one year before the implementation of the project activity. In case of a new to be built anaerobic open lagoons system, the residence time of organic matter in the lagoons should be determined following the guidance provided in Step 1 of the section "Procedure for the identification of the most plausible baseline scenario and assessment of additionality".

Finally, this methodology is only applicable if the most plausible baseline scenario, as determined by the "Procedure for the identification of the most plausible baseline scenario and assessment of additionality" further below in this methodology, is that:

- The wastewater would have been treated in an existing (W3) or new to be built (W6) anaerobic open lagoons system under clearly anaerobic conditions and without methane recovery and flaring;
- The sludge that would have been produced in the baseline lagoons system would have been dumped or left to decay (S1), or dried under controlled and aerobic conditions and then disposed to a landfill with methane recovery or used in soil application (S2);
- The electricity produced with biogas in the project scenario, if any, would have been produced using fossil fuels in a captive power plant (E1), or obtained from the grid (E2);
- The heat produced with biogas in the project scenario, if any, would have been produced using fossil fuels in a captive cogeneration power plant (H1), or using fossil fuels in a boiler (H2).

II. BASELINE METHODOLOGY

Project boundary

The spatial extent of the project boundary includes:

- The site and facilities where the wastewater and sludge are treated in both the baseline and the project scenario;
- Any on-site power plants that supply electricity to the wastewater and sludge treatment systems;
- Any on-site facilities that generate heat used by the wastewater and 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 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 1 below.

Table 1: Emission sources included in the project boundary

	Source	Gas		Justification / Explanation
Baseline	Wastewater and sludge treatment	CH_4	Included	Major source of emissions in the baseline.
		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 and thermal energy generation	CO_2	Included	Emissions from electricity/thermal energy generation in the baseline scenario arise from: (i) Electricity/thermal energy used for the operation of the baseline wastewater/sludge treatment systems; (ii) Electricity/thermal energy displaced by biogas based electricity/thermal energy generated in the project activity, if any.
		CH_4	Excluded	Excluded for simplification. This is conservative.
		N_2O	Excluded	Excluded for simplification. This is conservative.
	Transportation of sludge	CO_2	Included	Emissions from transportation of sludge may be included.
		CH_4	Excluded	Excluded for simplification. This is conservative.
		N_2O	Excluded	Excluded for simplification. This is conservative.
Project Activity	Wastewater and sludge treatment	CH_4	Included	Major source of emissions in the baseline.
		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 this is an important emission source.
	On-site use of electricity and fossil fuels	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.
	Transportation of sludge	CO_2	Included	Emissions from transportation of sludge may be included.
		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 and assessment of additionality

Project participants shall determine the most plausible baseline scenario and assess the additionality of the proposed project activity using the latest version of the "Combined tool to identify the baseline scenario and demonstrate additionality" agreed by the CDM Executive Board. The specific guidance described below should be used when applying the referred steps of the tool.

Step 1: Identification of alternative scenarios

The plausible alternative scenarios for wastewater and sludge treatment should be chosen so as to meet the water and sludge quality standards defined in the applicable legislation.

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

W1: Direct release of wastewaters to a nearby water body;
W2: Aerobic wastewater treatment facilities (e.g., activated sludge or filter bed type treatment);
W3: Existing anaerobic open lagoons system without methane recovery and flaring;
W4: Existing anaerobic open lagoons system with methane recovery and flaring;
W5: Existing anaerobic open lagoons system with methane recovery and utilization for energy generation;
W6: New to be built anaerobic open lagoons system without methane recovery and flaring;
W7: New to be built anaerobic open lagoons system with methane recovery and flaring;
W8: New to be built anaerobic open lagoons system with methane recovery and utilization for energy generation;
W9: Anaerobic digester without methane recovery and flaring;
W10: Anaerobic digester with methane recovery and flaring;
W11: Anaerobic digester with methane recovery and utilization for electricity or heat generation.

Plausible alternative scenarios for the treatment of sludge (S) should be determined.[1] These may include, but are not limited to, the following:

S1: The sludge would have been dumped or left to decay;
S2: The sludge would have been dried under controlled and aerobic conditions, with disposal in a landfill with methane recovery or with use in soil application;
S3: Disposal of sludge in sludge pits under clearly anaerobic conditions;
S4: Land application of the sludge;
S5: Composting;
S6: Mineralization;
S7: Disposal of sludge in a landfill without landfill gas capture;
S8: Disposal of sludge in a landfill with landfill gas capture and flare;
S9: Disposal of sludge in a landfill with landfill gas capture and utilization for energy generation;
S10: Anaerobic digestion without methane recovery;
S11: Anaerobic digestion with methane recovery and flaring;
S12: Anaerobic digestion with methane recovery and utilization for energy generation.

For the alternative scenarios involving new to be built anaerobic open lagoons systems (i.e., W6, W7 and W8), the specifications of the plausible alternative scenarios (including applicable options for sludge treatment) shall be defined as per the following steps:

[1] Please, note that the sludge being referred to here is not the sludge (type and quantity) produced in the project activity, but the sludge that would have been produced in the baseline scenario depending on the wastewater treatment technologies considered as plausible alternative scenarios.

(a) Define several design options for open lagoons systems that meet relevant regulations for treatment of the particular wastewater stream. Take into consideration the local conditions, such as environmental legislation, ground water table, land requirement, ambient temperature, etc.. Design specifications shall include average depth and surface area of the lagoons, electricity consumption, residence time of the organic matter and effluent adjustment factor (*AD*, as defined later on this methodology), 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. Offer conservative interpretations of this evidence;

(b) Verify the average depth of the design options, as determined in Step (a) above, based on a review of published literature establishing an average lagoon depth for the particular type of wastewater. If such literature does not exist, conduct a survey based on a control group of the five most recently constructed lagoons system in the geographical area, as defined in the "Combined tool to identify the baseline scenario and demonstrate additionality";

(c) If the average depth of the design options is deeper than the average depth identified through literature review or the control group in Step (b), 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 (b) is not a feasible option for the project activity. Provide transparent and documented evidence, and offer conservative interpretations of this evidence;

(d) The DOE undertaking the validation shall include an interview with an independent wastewater expert. During the interview, the expert shall confirm (i) the design parameters and (ii) the results of the literature review or the control group survey.

If the project activity includes electricity generation with biogas produced in a new anaerobic digester which treats the sludge from the aerobic wastewater treatment plant, 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 of energy.

If the project activity includes heat generation with biogas produced in a new anaerobic digester which treats the sludge from the aerobic wastewater treatment plant, plausible alternative scenarios for the generation of heat should be determined. These may include, but are not limited to, the following:

H1: Heat generation using fossil fuels in a captive cogeneration plant;
H2: Heat generation using fossil fuels in a boiler;
H3: Heat generation using renewable sources of energy.

Identify realistic and credible combinations of scenarios for wastewater treatment (W), sludge treatment (S), generation of electricity (E) and generation of heat (H), as applicable. The suggested list of alternatives above (W, S, E and H) is indicative. Project participants may propose other plausible alternatives and/or eliminate technically not feasible options from the list above, based on documented evidence. Make sure that the proposed project activity not being registered under the CDM is included amongst the realistic and credible combinations of scenarios.

Step 2: Barrier analysis

Project proponents cannot apply a barrier analysis as described in Step 2 of the "Combined tool to identify the baseline scenario and demonstrate additionality", but will have to undertake an investment analysis as described in Step 3. The investment analysis should take into account further guidance provided in the step below.[2]

Step 3: Investment analysis

Conduct an investment analysis as described in Step 3 of the "Combined tool to identify the baseline scenario and demonstrate additionality". The most cost-effective alternative (e.g. with the highest IRR) should be selected as the baseline scenario.

The following parameters should be included in the calculation and be explicitly 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 and/or heat 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).

For alternative scenarios involving new to be built anaerobic open lagoons systems (i.e., W6, W7 and W8), the DOE undertaking the validation shall include an interview with an independent wastewater expert. During the interview, the expert shall confirm the selection of the least cost lagoon design.

Baseline emissions

Baseline emissions are estimated as follows:

$$BE_y = BE_{CH4,ww,y} + BE_{CH4,sl,y} + BE_{EL,y} + BE_{HG,y} + BE_{TR,sl,y} \quad \textbf{(1)}$$

[2] The reason for a mandatory use of an investment analysis for this type of project activities is that aerobic wastewater treatment plants are often used as a preferred option in situations where tight water quality standards are required. Under such circumstances, the use of anaerobic open lagoons systems could become prohibitively expensive or even technically not feasible. Therefore, the assessment of having anaerobic open lagoons systems as a credible alternative to the proposed CDM project activity depends mainly on the costs of both options based on the project specific circumstances (e.g., water standards to be met, land availability, etc.). A barrier analysis, for example by using a "first of a kind" argument, could result in the project claiming emission reductions which never would have been a realistic alternative to the project activity.

Where:

BE_y	=	Baseline emissions in year y (tCO_2e/year)
$BE_{CH4,ww,y}$	=	Methane emissions from anaerobic treatment of the wastewater in the baseline scenario in year y (tCO_2e/year)
$BE_{CH4,sl,y}$	=	Methane emissions from treatment of sludge in the baseline scenario in year y (tCO_2e/year)
$BE_{EL,y}$	=	CO_2 emissions associated with electricity generation that is displaced by the project activity and/or electricity consumption in the baseline scenario in year y (tCO_2/year)
$BE_{HG,y}$	=	CO_2 emissions associated with fossil fuel combustion for heating equipment that is displaced by the project in year y (tCO_2/year)
$BE_{TR,sl,y}$	=	CO_2 emissions associated with transportation of sludge in the baseline scenario in year y (tCO_2/year)

Calculation of baseline emissions from treatment of wastewater ($BE_{CH4,ww,y}$)

Baseline methane emissions from anaerobic treatment of the wastewater in open lagoons are calculated using the so-called "methane conversion factor method" described below:

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

Where:

$BE_{CH4,ww,y}$	=	Methane emissions from anaerobic treatment of the wastewater in the baseline scenario in year y (tCO_2e/year)
GWP_{CH4}	=	Global Warming Potential of methane valid for the commitment period (tCO_2e/tCH_4)
B_o	=	Maximum methane producing capacity of wastewater, expressing the maximum amount of CH_4 that can be produced from a given quantity of chemical oxygen demand (tCH_4/tCOD)
$COD_{BL,ww,y}$	=	Quantity of chemical oxygen demand that would have been treated in the baseline scenario in year y (tCOD/year)
$MCF_{BL,ww,y}$	=	Average baseline methane conversion factor in year y, representing the fraction of organic load that would be degraded to CH_4 in the baseline scenario (fraction)

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

In principle, the baseline chemical oxygen demand ($COD_{BL,ww,y}$) corresponds to the chemical oxygen demand that is treated under the project activity ($COD_{PJ,ww,y}$) because the wastewater treated under the project activity would have been directed to the open lagoons in the baseline scenario, thus:

$$COD_{BL,ww,y} = COD_{PJ,ww,y} \quad \textbf{(3)}$$

However, if there would be an effluent from the lagoons in the baseline, $COD_{BL,ww,y}$ should be adjusted by an effluent adjustment factor which relates the COD supplied to the lagoon with the COD in the effluent, as follows:

$$COD_{BL,ww,y} = AD_{BL} \times COD_{PJ,ww,y} \quad \textbf{(4)}$$

Where:

$COD_{BL,ww,y}$ = Quantity of chemical oxygen demand that would have been treated in the baseline scenario in year y (tCOD/year)

AD_{BL} = Effluent adjustment factor expressing the percentage of COD that is degraded in open lagoons in the baseline scenario (fraction)

$COD_{PJ,ww,y}$ = Quantity of chemical oxygen demand that is treated in the aerobic wastewater treatment plant in the project activity in year y (tCOD/year)

Determination of $COD_{PJ,ww,y}$

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

Where:

$COD_{PJ,ww,y}$ = Quantity of chemical oxygen demand that is treated in the aerobic wastewater treatment plant in the project activity in year y (tCOD/year)

$Q_{PJ,ww,m}$ = Quantity of wastewater that is treated in the aerobic wastewater treatment plant in the project activity in month m (m^3)

$w_{PJ,COD,ww,m}$ = Average chemical oxygen demand in the wastewater that is treated in the aerobic wastewater treatment plant in the project activity in month m ($tCOD/m^3$)

m = Months of year y of the crediting period

Determination of AD_{BL}

If the baseline scenario is identified as being a new to be built anaerobic open lagoons system (W6), AD_{BL} is determined based on the design features that were identified using the procedure outlined in Step 1 of the "Procedure for the identification of the most plausible baseline scenario and assessment of additionality". "Option A" below should be used applying the design COD inflow for $COD_{BL,in,x}$ and the design COD effluent for $COD_{BL,out,x}$.

Otherwise, if the baseline scenario is identified as being existing open lagoons (W3), use either Option (A) or Option (B) below to determine AD_{BL}, as applicable:

Option A: In case at least one year historical data of the COD inflow and COD effluent are available, AD_{BL} should be determined as follows:

$$AD_{BL} = 1 - \frac{COD_{BL,out,x}}{COD_{BL,in,x}} \quad \textbf{(6)}$$

Where:

AD_{BL} = Effluent adjustment factor expressing the percentage of COD that is degraded in open lagoons in the baseline scenario (fraction)

$COD_{BL,out,x}$ = COD of the effluent of open lagoons in the baseline scenario in the period x (tCOD)

$COD_{BL,in,x}$ = COD directed to the open lagoons in the baseline scenario in the period x (tCOD)

x = Representative historical reference period (at least one year)

Option B: In case at least one year historical data of the COD inflow and COD effluent are not available, AD_{BL} should be determined by conducting measurements of the COD inflow to and effluent from the lagoons 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 $COD_{BL,in,x}$ and $COD_{BL,out,x}$ values from the measurement campaign shall be used in "Option A" 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.

Determination of $MCF_{BL,ww,y}$

The quantity of methane generated from COD disposed to the open lagoon 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 $f_{BL,T,y}$ 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. $MCF_{BL,ww,y}$ is calculated as follows:

$$MCF_{BL,ww,y} = f_{BL,d} \times f_{BL,T,y} \times 0.89 \tag{7}$$

Where:

$MCF_{BL,ww,y}$	=	Average baseline methane conversion factor in year *y*, representing the fraction of organic load that would be degraded to CH_4 in the baseline scenario (fraction)
$f_{BL,d}$	=	Factor expressing the influence of the depth of the lagoon on methane generation (fraction)
$f_{BL,T,y}$	=	Factor expressing the influence of the temperature on the methane generation in year *y* (fraction)
0.89	=	Conservativeness factor

For the purpose of *ex ante* estimations, IPCC default values of methane conversion factors (MCF) for different treatment types and conditions should be used as per IPCC Guidelines.

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

In some regions, the ambient temperature varies significantly over the year. Therefore, the factor $f_{BL,T,y}$ is calculated with the help of a monthly stock change model which aims at assessing how much COD degrades in each month. Based on monthly values of $f_{T,m}$ the annual value $f_{BL,T,y}$ is calculated as follows:

$$f_{BL,T,y} = \frac{\sum_{m=1}^{12} f_{T,m} \times COD_{BL,available,m}}{\sum_{m=1}^{12} AD_{BL} \times Q_{PJ,ww,m} \times w_{PJ,ww,COD,m}} \tag{8}$$

Where:

$f_{BL,T,y}$	=	Factor expressing the influence of the temperature on the methane generation in year *y* (fraction)
$f_{T,m}$	=	Factor expressing the influence of the temperature on the methane generation in month *m* (fraction)
$COD_{BL,available,m}$	=	Quantity of chemical oxygen demand available for degradation in month *m* (tCOD)
AD_{BL}	=	Effluent adjustment factor expressing the percentage of COD that is degraded in open lagoons in the baseline scenario (fraction)
$Q_{PJ,ww,m}$	=	Quantity of wastewater that is treated in the aerobic wastewater treatment plant in the project activity in month *m* (m^3)
$w_{PJ,COD,ww,m}$	=	Average chemical oxygen demand in the wastewater that is treated in the aerobic wastewater treatment plant in the project activity in month *m* ($tCOD/m^3$)
m	=	Months of year *y* of the crediting period

Determination of $f_{T,m}$

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

$$f_{T,m} = \begin{cases} 0 & if \quad T_{2,m} < 283\ K \\ exp\left(\dfrac{E \times (T_{2,m} - T_1)}{R \times T_1 \times T_{2,m}}\right) & if \quad 283\ K < T_{2,m} < 303\ K \\ 1 & if \quad T_{2,m} > 303\ K \end{cases} \tag{9}$$

Where:

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

As indicated in the 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.

Determination of $COD_{BL,available,m}$

The quantity of chemical oxygen demand available for degradation in the open lagoon for each month *m*, is given by the balance of the quantities of wastewater directed to the lagoon, the quantity of organic compounds that decay in the lagoons, and the quantity of any effluent water from the lagoon. Therefore, $COD_{BL,available,m}$ 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:

$$COD_{BL,available,m} = AD_{BL} \times Q_{PJ,ww,m} \times w_{PJ,COD,ww,m} + (1 - f_{T,m}) \times COD_{BL,available,m-1} \tag{10}$$

Where:

$COD_{BL,available,m}$	=	Quantity of chemical oxygen demand available for degradation in month *m* (tCOD)
AD_{BL}	=	Effluent adjustment factor expressing the percentage of COD that is degraded in open lagoons in the baseline scenario (fraction)
$Q_{PJ,ww,m}$	=	Quantity of wastewater that is treated in the aerobic wastewater treatment plant in the project activity in month *m* (m^3)
$w_{PJ,COD,ww,m}$	=	Average chemical oxygen demand in the wastewater that is treated in the aerobic wastewater treatment plant in the project activity in month *m* ($tCOD/m^3$)
$f_{T,m}$	=	Factor expressing the influence of the temperature on the methane generation in month *m* (fraction)
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 is less than one year, carry-over calculations are limited to the period where the wastewater remains in the lagoon. In other words, in case the lagoon is emptied, the inflow and COD available from the previous month should be set to zero and the accumulation of organic matter should be started again. Project participants should provide evidence of the typical residence time of the organic matter in the lagoon.

If the baseline scenario is identified as being a new to be built anaerobic open lagoons system (W6), use the residence time of organic matter according to the design features of the lagoon that was identified using the procedure outlined in Step 1 of the "Procedure for the identification of the most plausible baseline scenario and assessment of additionality".

Calculation of baseline emissions from treatment of sludge ($BE_{CH4,sl,y}$)

If the sludge that would have been produced in the baseline scenario from the treatment of wastewater in the open lagoons system would have been treated by means of controlled drying under aerobic conditions and then disposed to a landfill with methane recovery or with use in soil application (S2), the corresponding methane emissions ($BE_{CH4,sl,y}$) are considered to be negligible and are not accounted for. Therefore:

$$BE_{CH4,sl,y} = 0 \tag{11}$$

This is conservative since this will lead to lower baseline emissions.

Otherwise, if the sludge that would have been produced in the baseline scenario from the treatment of wastewater in the open lagoons system would have been dumped or left to decay (S1), corresponding methane emissions ($BE_{CH4,sl,y}$) are calculated as:

$$BE_{CH4,sl,y} = \frac{16}{12} \times GWP_{CH4} \times F \times DOC_F \times MCF_{BL,sl} \times DOC_{BL,sl} \times Q_{BL,sl,y} \tag{12}$$

Where:

$BE_{CH4,sl,y}$	=	Methane emissions from treatment of sludge in the baseline scenario in year *y* (tCO_2e/year)
16/12	=	Ratio between molar mass of methane and molar mass of carbon

GWP_{CH4}	=	Global Warming Potential of methane valid for the commitment period (tCO_2e/tCH_4)
F	=	Fraction of methane in the gas. IPCC default value of 0.5 should be used (fraction)
DOC_F	=	Fraction of degradable organic content dissimilated to biogas. The IPCC default value of 0.5 should be used (fraction)
$MCF_{BL,sl}$	=	Methane conversion factor for the site where sludge would have been dumped or left to decay in the baseline (fraction)
$DOC_{BL,sl}$	=	Degradable organic content of the sludge that would have been produced in the baseline scenario in year *y*. IPCC default values should be used: 0.05 for domestic sludge (wet basis, considering a default dry matter content of 10%) and 0.09 for industrial sludge (wet basis, assuming dry matter content of 35%) (fraction)
$Q_{BL,sl,y}$	=	Quantity of sludge that would have been produced and treated in the baseline scenario in year *y* (tonnes/year)

Determination of $MCF_{BL,sl}$

The average baseline methane conversion factor for sludge ($MCF_{BL,sl}$) should be determined in accordance with the guidance provided in IPCC 2006 Guidelines for National Greenhouse Gas Inventories. The same is provided below:

Type of disposal site	$MCF_{BL,sl,y}$
Anaerobic managed solid waste disposal sites - These must have controlled placement of waste (i.e. waste directed to specific deposition area, a degree of control of scavenging and a degree of control of fires) and will include at least one of the following: (i) Cover material; (ii) Mechanical compacting; (iii) Levelling of the waste.	1.0
Semi-anaerobic managed solid waste disposal sites - These must have controlled placement of waste and will include all of the following structures for introducing air to waste layer: (i) Permeable cover material; (ii) Leachate drainage system; (iii) Regulating pondage; (iv) Gas ventilation system.	0.5
Unmanaged solid waste disposal site (deep and/or with high water table) - This comprises of all solid waste disposal sites not meeting the criteria of managed solid waste disposal sites and which have depths of greater than or equal to 5 metres and/or high water table at near ground level. Latter situation corresponds to filling inland water, such as pond, river or wetland, by waste.	0.8
Unmanaged shallow solid waste disposal sites- This comprises all solid waste disposal sites not meeting the criteria of managed solid waste disposal sites and which have depths of less than 5 metres.	0.4

Type of disposal site	$MCF_{BL,sl,y}$
Uncategorized solid waste disposal sites- Only if the project proponents cannot categorize their SWDS into above four categories of managed and unmanaged SWDS, the MCF for this category can be used.[3]	0.4

Calculation of baseline emissions from consumption of electricity ($BE_{EL,y}$)

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

- Baseline emissions from consumption of electricity associated with the treatment of wastewater;
- 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 for the generation of power in the project activity and/or consumption of electricity in the baseline are calculated as follows:

$$BE_{EL,y} = \left(EC_{BL,y} + EG_{PJ,y}\right) \times EF_{BL,EL,y} \quad \textbf{(13)}$$

Where:

$BE_{EL,y}$	=	CO_2 emissions associated with electricity generation that is displaced by the project activity and/or electricity consumption in the baseline scenario in year y (tCO_2/year)
$EC_{BL,y}$	=	Annual quantity of electricity that would be consumed in the baseline scenario for the treatment of the wastewater and sludge (MWh)
$EG_{PJ,y}$	=	Net quantity of electricity generated in year y with biogas from the new anaerobic biodigester, if applicable (MWh)
$EF_{BL,EL,y}$	=	Emission factor for electricity generated and/or consumed in the baseline scenario in year y (tCO_2/MWh)
y	=	Year of the crediting period

Determination of $EF_{BL,EL,y}$

To determine the baseline emission factor for electricity generation in the baseline, the following scenarios have to be considered for the displacement of electricity by the project:

Scenario A: **Displacement of electricity generation in the grid.** The electricity is supplied to/purchased from the grid only. Either no captive power plant is installed at the site of electricity consumption or, if any on-site captive power plant exists, it is not operating or it can not change its operation as a result of the project activity.

[3] For uncategorized solid waste disposal sites, the IPCC prescribes an MCF equal to 0.6. For conservativeness reasons, the value 0.4 should be used instead in this methodology.

Scenario B: **Displacement of electricity from (an) off-grid fossil fuel fired captive power plant(s).** One or more fossil fuel fired captive power plants are installed at the site of the electricity consumption source. The captive power plant(s) is/are not connected to the electricity grid. Under the project activity, no power is fed into the grid.

Scenario C: **Displacement of electricity from the grid and (a) fossil fuel fired captive power plant(s).** One or more fossil fuel fired captive power plants operate at the site of the project activity or have been operated prior to the implementation of the project and would continue to operate in the baseline scenario. The power generation under the project activity may displace electricity generation in both the captive power plant(s) or the grid. Similarly, electricity demand in the baseline may be generated by the captive power plan(s) or the grid.

For the determination of $EF_{BL,EL,y}$ the three corresponding scenarios in the latest approved version of the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" should be applied to calculate baseline emissions from electricity consumption ($BE_{EC,y}$).

Baseline emissions from the generation of heat ($BE_{HG,y}$)

This step is applicable if the biogas captured from the new anaerobic digester in the project scenario is used for heat generation.

If the baseline scenario for heat generation is that heat would have been generated using fossil fuels in a captive cogeneration plant (H1):[4]

$$BF_{HG,y} = 0 \tag{14}$$

If the heat, in the baseline, would have been generated using fossil fuels in a boiler (H2), baseline emissions are calculated as follows:

$$BE_{HG,y} = \frac{HG_{PJ,y} \times EF_{CO2,FF,heat}}{\eta_{BL,heat}} \tag{15}$$

Where:

$BE_{HG,y}$	=	CO_2 emissions associated with fossil fuel combustion for heat production in the baseline scenario in year y (tCO_2/year)
$HG_{PJ,y}$	=	Net quantity of heat generated in year y with biogas from the new anaerobic digester (TJ)
$EF_{CO2,FF,heat}$	=	CO_2 emission factor of the fossil fuel used for heat generation in the baseline scenario (tCO_2/TJ)
$\eta_{BL,heat}$	=	Efficiency of the boiler that would be used for heat generation in the baseline scenario (fraction)
y	=	Year of the crediting period

4 In case of production of heat in a cogeneration plant in the baseline scenario (H1), the emission reductions from using the biogas for heat production are already reflected in the emissions related to electricity production.

Baseline emissions from transportation of sludge ($BE_{TR,sl,y}$)

The baseline emissions resulting from transportation of sludge that would have been produced in the baseline scenario should be calculated as:

$$BE_{TR,sl,y} = \sum_i N_{BL,i,y} \times D_{BL,i} \times F_{BL,i} \times NCV_{BL,j} \times EF_{BL,j} \qquad \textbf{(16)}$$

Where:

$BE_{TR,sl,y}$	=	CO_2 emissions associated with transportation of sludge in the baseline scenario in year *y* (tCO_2/year)
$N_{BL,i,y}$	=	Number of trips (vehicle of type *i* with similar loading capacity) for transportation of the sludge that would have been produced in the baseline scenario in year *y* (trips)
$D_{BL,i}$	=	Average distance per trip, that would have been travelled by the transportation vehicle of type *i*, for transportation of sludge in the baseline scenario (km)
$F_{BL,i}$	=	Specific fuel consumption of the transportation vehicle of type *i* (mass or volume units of fuel/km)
$NCV_{BL,j}$	=	Net calorific value of the transportation fuel *j* (TJ/mass or volume units)
$EF_{BL,j}$	=	CO_2 emission factor of the transportation fuel *j* (tCO_2/TJ)
i	=	Vehicle type
j	=	Fuel type used in vehicles
y	=	Year of the crediting period

If the emissions associated with transportation of sludge in the baseline scenario and in the project scenario are found to be comparable (i.e. within +1% range) or emissions in the project scenario are lower, then both can be excluded in the calculation of baseline emissions and project emissions as a simplification.

Determination of $N_{BL,i,y}$

The number of trips of the transportation vehicle of type *i* is calculated as:

$$N_{BL,i,y} = \frac{Q_{BL,sl,y}}{q_{BL,i}} \qquad \textbf{(17)}$$

Where:

$N_{BL,i,y}$	=	Number of trips (vehicle of type *i* with similar loading capacity) for transportation of final sludge generated by the waste water treatment system in the baseline scenario in the year *y* (trips)
$Q_{BL,sl,y}$	=	Quantity of sludge that would have been produced and treated in the baseline scenario in the year *y* (tonnes)
$q_{BL,i}$	=	Average vehicular capacity of the transportation vehicle of type *i* (tonnes/trip)
y	=	Year of the crediting period

Project emissions

Project emissions are calculated as follows:

$$PE_y = PE_{CH4,ww,y} + PE_{CH4,sl,y} + PE_{N2O,sl,y} + PE_{EC,y} + PE_{FC,y} + PE_{TR,sl,y} \quad \textbf{(18)}$$

Where:

PE_y	=	Project emissions in year y (tCO_2e/year)
$PE_{CH4,ww,y}$	=	Methane emissions from treatment of wastewater in the project activity in year y (tCO_2e/year)
$PE_{CH4,sl,y}$	=	Methane emissions from treatment of sludge in the project activity in year y (tCO_2e/year)
$PE_{N2O,sl,y}$	=	N_2O emissions from treatment of sludge in the project activity in year y (tCO_2e/year)
$PE_{EC,y}$	=	Project emissions from electricity consumption in year y (tCO_2e/year)
$PE_{FC,y}$	=	Project emissions from fossil fuel consumption in year y (tCO_2e/year)
$PE_{TR,sl,y}$	=	CO_2 emissions associated with transportation of sludge in the project activity in year y (tCO_2/year)
y	=	Year of the crediting period

Methane emissions from treatment of wastewater ($PE_{CH4,ww,y}$)

Project emissions due to wastewater treatment comprise two components, emissions from the aerobic wastewater treatment plant due to inadequate operation and/or overloading, and emissions due to the presence of degradable organic carbon in the treated wastewater after leaving the aerobic wastewater treatment plant:

$$PE_{CH4,ww,y} = PE_{CH4,wwtp,y} + PE_{CH4,effl,y} \quad \textbf{(19)}$$

Where:

$PE_{CH4,ww,y}$	=	Methane emissions from treatment of wastewater in the project activity in year y (tCO_2e/year)
$PE_{CH4,wwtp,y}$	=	Methane emissions from the aerobic wastewater treatment plant in year y due to inadequate operation and/or overloading (tCO_2e/year)
$PE_{CH4,effl,y}$	=	Methane emissions due to the presence of degradable organic carbon in the effluent from the aerobic wastewater treatment plant in year y (tCO_2e/year)

Methane emissions from the aerobic wastewater treatment plant $PE_{CH4,wwtp,y}$

Although aerobic wastewater treatment plants are designed to operate under aerobic conditions, thereby resulting in negligible emissions of methane, the IPCC recognizes that several factors may render an aerobic wastewater treatment plant to develop anaerobic conditions during operation, thereby resulting in emissions of methane which cannot be disregarded. The IPCC guidelines propose a set of default values for methane conversion factors (MCF) in aerobic treatment plant, ranging from 0 to 0.4, depending on plant management as follows:

- Well managed plants (some CH4 can be emitted from settling basins and other pockets): the default MCF value is 0 (range 0 - 0.1);
- Not well managed plant: the default MCF value is 0.4 (range 0 - 0.4).

Those MCF ranges are designed to account for different operational problems which can arise in aerobic treatment systems, and subsequently lead to the development of anaerobic conditions and the conversion of a fraction of the organic matter to CH4 rather than to CO2 (i.e. anaerobically rather than aerobically). Factors which influence wastewater treatment plants operation in this context include:

- General hydraulic design and operation: most wastewater treatment plants are designed to maximise gravity flow and minimise the need for mechanical pumping (due to operational costs of pumping). Whatever the approach adopted, the design must maintain full flow and mixing of the wastewater through the different treatment units (e.g. primary sedimentation tanks, aeration tanks, secondary clarifiers/final settlement tanks), as well as within connecting channels and pipework. Poor design can lead to the development of "dead zones" i.e., areas where particulates accumulate, which, if left untreated, may lead to the formation of anaerobic condition, and subsequently CH4 emissions;
- Hydraulic short-circuiting (in activated sludge plants, biofilter plant): excessive build up of sludge, or the formation of large sludge flocks or filamentous algae can lead to sludge bulking within treatment units, which can result in hydraulic short-circuiting i.e. conditions where the wastewater passes through the plant at higher than design rates. In biofilter plants, blocked nozzles on rotor distribution arms can also lead to lead to poor distribution of wastewater, and create sludge build ups in the filter matrix. The lack of mixing in the areas where sludge has built up can result in anaerobic conditions developing, and thus the formation of CH4;
- Loading: loading of unit processes is a key design consideration for wastewater treatment plants. Overloading of a plant can lead to both poor hydraulic conditions evolving, and poor performance of the biological treatment processes as the residence time in the treatment units is not sufficient to allow the bacteria to breakdown organic matter. Large variations in flow to the plant, coupled with poor plant sizing, can augment these problems. Shock loads can also lead to temporary reductions in plant performance, which can result in the development of plant irregularities as described previously;
- Mixing and aeration efficiency (activated sludge plants and oxidation ditches): good mixing, either through surface aeration of diffuse aeration systems, is critical to system efficacy and to maintain sufficient dissolved oxygen (DO) levels in the aeration tank for the given level of load;
- Development of anaerobic micro-environments within bioflocs: under certain circumstances, development of a bulky sludge can lead to the evolution of micro-anaerobic environments within sludge flocs, which in turn can give rise to the development of micro anaerobic communities, which can lead to CH4 formation. These conditions can also arise under normal operations, and operational practices to avoid sludge bulking, such as chemical addition, can be undertaken;
- Frequency of desludging/sludge wasting: appropriate rates of desludgeing of tanks is critical to avoid excessive sludge build up within treatment units, which can lead to anaerobic conditions developing within the tank sludge blanket. Desludging is also important to maintain the correct F/M ratio.

Due to the highly site specific nature of the factors leading to the development of anaerobic conditions in aerobic wastewater treatment plants, it is difficult to provide a clear-cut procedure and monitoring parameters to determine CH_4 emissions for plants under inadequate operational conditions. This

methodology applies a proxy parameter, the oxidisation ratio (*OR*) described further below. In order to conservatively account for emissions, the higher value (MCF=0.4) of the IPCC MCF range for aerobic treatment plant should be used if the oxidisation ratio (*OR*) is out of an acceptable range. If the oxidisation ratio is within the acceptable range, emissions should be considered zero.

Therefore, methane emissions from the aerobic wastewater treatment plant in year *y* due to inadequate operation and/or overloading should be calculated as follows:

$$PE_{CH4,wwtp,y} = \begin{cases} 0 \quad ,if \quad OR_i \geq 0.8 \\ \sum_{i=1}^{365} GWP_{CH4} \times B_o \times 0.4 \times \left(COD_{PJ,ww,i} - COD_{PJ,effl,i}\right) \quad ,if \quad OR_i < 0.8 \end{cases} \tag{20}$$

Where:

$PE_{CH4,wwtp,y}$	=	Methane emissions from the aerobic wastewater treatment plant in year *y* due to inadequate operation and/or overloading (tCO_2e/year)
OR_i	=	Oxidisation ratio, representing the ratio between organic matter in the output and organic matter in the input of the aerobic wastewater treatment plant in day *i* of year *y* (fraction)
GWP_{CH4}	=	Global Warming Potential of methane valid for the commitment period (tCO_2e/tCH_4)
B_o	=	Maximum methane producing capacity of wastewater treated in the year *y*, expressing the maximum amount of CH_4 that can be produced from a given quantity of chemical oxygen demand (tCH_4/tCOD)
0.4	=	Default methane conversion factor (MCF) for not well managed plants (fraction)
$COD_{PJ,ww,i}$	=	Quantity of chemical oxygen demand that enters the aerobic wastewater treatment plant in the project activity in the day *i* of year *y* (tCOD)
$COD_{PJ,effl,i}$	=	Quantity of chemical oxygen demand in the effluent of the wastewater treatment plant in the project activity in the day *i* of year *y* (tCOD)

Determination of the quantities of chemical oxygen demands ($COD_{PJ,ww,i}$ and $COD_{PJ,effl,i}$)

The quantities of chemical oxygen demands in the wastewater and effluent are calculated as follows:

$$COD_{PJ,ww,i} = Q_{PJ,ww,i} \times w_{PJ,COD,ww,i}$$

$$COD_{PJ,effl,i} = Q_{PJ,effl,i} \times w_{PJ,COD,effl,i} \tag{21}$$

Where:

$COD_{PJ,ww,i}$	=	Quantity of chemical oxygen demand that enters the aerobic wastewater treatment plant in the project activity in the day *i* of year *y* (tCOD)
$Q_{PJ,ww,i}$	=	Quantity of wastewater that is treated in the aerobic wastewater treatment plant in the project activity in day *i* of year *y* (m^3)
$w_{PJ,COD,ww,i}$	=	Average chemical oxygen demand in the wastewater that is treated in the aerobic wastewater treatment plant in the project activity in day *i* of year *y* (tCOD/m^3)
$COD_{PJ,effl,i}$	=	Quantity of chemical oxygen demand in the effluent of the wastewater treatment plant in the project activity in the day *i* of year *y* (tCOD)

$Q_{PJ,effl,i}$ = Quantity of effluent that leaves the aerobic wastewater treatment plant in the project activity in day *i* of year *y* (m³)

$w_{PJ,COD,effl,i}$ = Average chemical oxygen demand in the effluent that leaves the aerobic wastewater treatment plant in the project activity in day *i* of year *y* (tCOD/m³)

Determination of the oxidisation ratio (OR_i)

The determination of whether the aerobic wastewater treatment system is well operated (managed) or not is made by monitoring the quality of the wastewater at the outlet of the treatment plant to make sure it meets the target specified in the proposed design of the proposed CDM project activity. If it does meet this requirement it can be trusted to be a well managed facility with little to no CH4 emissions during the project implementation. This approach is considered as appropriate, but the following two problems are often encountered:

- In many developing countries the urban areas either do not have separate storm water drain systems or the storm water drain systems do not work properly. Due to this reason, during rainy seasons, the wastewater gets diluted from the ingress of rainwater before reaching the treatment plant. Because of the dilution effect, the COD in the wastewater decreases and can appear within the acceptable range even if the treatment plant is not in operation;
- The legislation in many of the developing countries specifies the maximum limit for wastewater COD, but the legislation generally does not specify the particular wastewater treatment technology which should be used to achieve the objective. It is possible to achieve an acceptable level of COD in the final effluent by diluting it (directly mixing water to it) just before it is discharged into the final receiving body (mostly fresh water streams).

To address these two issues, the following approach is suggested:

$$OR_i = \frac{COD_{PJ,ww,i} - COD_{PJ,effl,i}}{COD_{PJ,ww,i}} \quad \textbf{(22)}$$

Where:

OR_i = Oxidisation ratio, representing the ratio between organic matter in the output and organic matter in the input of the aerobic wastewater treatment plant in day *i* of year *y* (fraction)

$COD_{PJ,ww,i}$ = Quantity of chemical oxygen demand that enters the aerobic wastewater treatment plant in the project activity in the day *i* of year *y* (tCOD)

$COD_{PJ,effl,i}$ = Quantity of chemical oxygen demand in the effluent of the wastewater treatment plant in the project activity in the day *i* of year *y* (tCOD)

Methane emissions due to the presence of degradable organic carbon in the effluent $PE_{CH4,effl,y}$

The methane emissions due to the presence of degradable organic carbon in the effluent from the aerobic wastewater treatment plant are calculated as:

$$PE_{CH4,effl,y} = GWP_{CH4} \times B_o \times MCF_{PJ,effl,y} \times \sum_{i=1}^{365} COD_{PJ,effl,i} \quad \textbf{(23)}$$

Where:

$PE_{CH4,effl,y}$	=	Methane emissions due to the presence of degradable organic carbon in the effluent from the aerobic wastewater treatment plant in year *y* (tCO_2e/year)
GWP_{CH4}	=	Global Warming Potential of methane valid for the commitment period (tCO_2e/tCH_4)
B_o	=	Maximum methane producing capacity of wastewater treated in the year *y*, expressing the maximum amount of CH_4 that can be produced from a given quantity of chemical oxygen demand (tCH_4/tCOD)
$MCF_{PJ,effl,y}$	=	Average methane conversion factor in year *y*, representing the fraction of organic load in the effluent that is degraded to CH_4 in year *y*. The factor is based on the type of treatment and discharge pathway of the effluent of the aerobic wastewater treatment plant (fraction)
$COD_{PJ,effl,i}$	=	Quantity of chemical oxygen demand in the effluent of the wastewater treatment plant in the project activity in the day *i* of year *y* (tCOD)
y	=	Year of the crediting period

Determination of $MCF_{PJ,effl,y}$

The methane conversion factor is calculated based on a factor $f_{PJ,d}$, expressing the influence of the depth and a factor $f_{PJ,T,y}$ 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. $MCF_{PJ,effl,y}$ is calculated as follows:

$$MCF_{PJ,effl,y} = f_{PJ,d,y} \times f_{PJ,T,y} \times 0.89 \tag{24}$$

Where:

$MCF_{BL,effl,y}$	=	Average baseline methane conversion factor in year *y*, representing the fraction of organic load in the effluent that is degraded to CH_4 in year *y*. The factor is based on the type of treatment and discharge pathway of the effluent of the aerobic wastewater treatment plant (fraction)
$f_{PJ,d,y}$	=	Factor expressing the influence of the depth on methane generation in year *y*
$f_{PJ,T,y}$	=	Factor expressing the influence of the temperature on the methane generation in year *y*
0.89	=	Conservativeness factor

For the purpose of *ex ante* estimations, IPCC default values of methane conversion factors (MCF) for different treatment types and conditions should be used as per IPCC Guidelines.

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

In some regions, the ambient temperature varies significantly over the year. Therefore, the factor $f_{PJ,T,y}$ is calculated with the help of a monthly stock change model which aims at assessing how much COD degrades in each month. Based on monthly values of $f_{T,m}$ the annual value $f_{PJ,T,y}$ is calculated as follows:

$$f_{PJ,T,y} = \frac{\sum_{m=1}^{12} f_{T,m} \times COD_{PJ,available,m}}{\sum_{m=1}^{12} Q_{PJ,effl,m} \times w_{PJ,COD,effl,m}} \tag{25}$$

Where:

$f_{PJ,T,y}$ = 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*
$COD_{PJ,available,m}$ = Quantity of chemical oxygen demand in the effluent from the aerobic wastewater treatment plant available for degradation in month *m* (tCOD)
$Q_{PJ,effl,m}$ = Quantity of effluent that leaves the aerobic wastewater treatment plant in the project activity in month *m* of year *y* (m³)
$w_{PJ,COD,effl,m}$ = Average chemical oxygen demand in the effluent that leaves the aerobic wastewater treatment plant in the project activity in month *m* of year *y* (tCOD/m³)
m = Months of year *y* of the crediting period

Determination of $COD_{PJ,available,m}$

The quantity of chemical oxygen demand available in the effluent for each month *m*, is given by the balance of the quantities of COD in the effluent, the quantity of organic compounds that decay, and the quantity of final effluent. Therefore, $COD_{PJ,available,m}$ is assumed to be equal to the amount of organic matter directed to the discharge pathway, less final effluent, plus the COD that may have remained in the discharge pathway from previous months, as follows:

$$COD_{PJ,available,m} = Q_{PJ,effl,m} \times w_{PJ,COD,effl,m} + (1 - f_{T,m}) \times COD_{PJ,available,m-1} \quad \textbf{(26)}$$

Where:

$COD_{PJ,available,m}$ = Quantity of chemical oxygen demand available for degradation in the effluent from the aerobic wastewater treatment plant in month *m* (tCOD)
$Q_{PJ,effl,m}$ = Quantity of effluent that leaves the aerobic wastewater treatment plant in the project activity in month *m* of year *y* (m³)
$w_{PJ,COD,effl,m}$ = Average chemical oxygen demand in the effluent that leaves the aerobic wastewater treatment plant in the project activity in month *m* of year *y* (tCOD/m³)
$f_{T,m}$ = 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.

Methane emissions from treatment of sludge in the project activity in year y ($PE_{CH4,sl,y}$)

The sludge produced in the aerobic wastewater treatment plant can be treated in the project scenario by means of one of the following methods:

(1) The sludge is dried under controlled and aerobic conditions, and then disposed to a landfill with methane recovery or used in soil application;

(2) The sludge is dumped or left to decay;

(3) The sludge is treated in a new anaerobic digester, with the biogas extracted from the anaerobic digester being flared and/or used to generate electricity and/or heat. The residues from the anaerobic digester after treatment are dehydrated, limed and stored before final disposal in a controlled landfill.

Corresponding project emissions should be calculated accordingly as explained below.

Calculation of $PE_{CH4,sl,y}$ if the sludge is dried under controlled and aerobic conditions

If the sludge is dried under controlled and aerobic conditions, and then disposed to a landfill with methane recovery or used in soil application, corresponding project emissions are considered to be negligible and should not be accounted for. Therefore:

$$PE_{CH4,sl,y} = 0 \quad \textbf{(27)}$$

Calculation of $PE_{CH4,sl,y}$ if the sludge is dumped or left to decay

If the sludge is dumped or left to decay, corresponding project emissions should be determined as:

$$PE_{CH4,sl,y} = \frac{16}{12} \times GWP_{CH4} \times F \times DOC_F \times MCF_{PJ,sl,y} \times DOC_{PJ,sl,y} \times Q_{PJ,sl,y} \quad \textbf{(28)}$$

Where:

$PE_{CH4,sl,y}$	=	Methane emissions from treatment of sludge in the project activity in year *y* (tCO_2e/year)
16/12	=	Ratio between molar mass of methane and molar mass of carbon
GWP_{CH4}	=	Global Warming Potential of methane valid for the commitment period (tCO_2e/tCH_4)
F	=	Fraction of methane in the gas. IPCC default value of 0.5 should be used (fraction)
DOC_F	=	Fraction of degradable organic content dissimilated to biogas. The IPCC default value of 0.5 should be used (fraction)
$MCF_{PJ,sl,y}$	=	Methane conversion factor for the site where sludge is dumped or left to decay in the year *y* (fraction)
$DOC_{PJ,sl,y}$	=	Degradable organic content of the sludge produced in year *y* . IPCC default values should be used: 0.05 for domestic sludge (wet basis, considering a default dry matter content of 10%) and 0.09 for industrial sludge (wet basis, assuming dry matter content of 35%) (fraction)
$Q_{PJ,sl,y}$	=	Quantity of sludge produced in the project activity in the year *y* (tonnes)

Determination of $MCF_{PJ,sl,y}$

The methane conversion factor for the site where sludge is dumped or left to decay is determined in accordance with the guidance provided in IPCC 2006 Guidelines for National Greenhouse Gas Inventories. The same is provided below:

Type of disposal site	$\boldsymbol{MCF_{PJ,sl,y}}$
Anaerobic managed solid waste disposal sites - These must have controlled placement of waste (*i.e.* waste directed to specific deposition area, a degree of control of scavenging and a degree of control of fires) and will include at least one of the following: (i) cover material; (ii) mechanical compacting; (iii) levelling of the waste.	1.0

Semi-anaerobic managed solid waste disposal sites - These must have controlled placement of waste and will include all of the following structures for introducing air to waste layer: (i) permeable cover material; (ii) leachate drainage system; (iii) regulating pondage; (iv) gas ventilation system.	0.5
Unmanaged solid waste disposal site (deep and/or with high water table) - This comprises of all solid waste disposal sites not meeting the criteria of managed solid waste disposal sites and which have depths of greater than or equal to 5 metres and/or high water table at near ground level. Latter situation corresponds to filling inland water, such as pond, river or wetland, by waste.	0.8
Unmanaged shallow solid waste disposal sites- This comprises all solid waste disposal sites not meeting the criteria of managed solid waste disposal sites and which have depths of less than 5 metres.	0.4
Uncategorized solid waste disposal sites- Only if countries cannot categorize their SWDS into above four categories of managed and unmanaged SWDS, the MCF for this category can be used.[5]	1.0

Calculation of $PE_{CH4,sl,y}$ if the sludge is treated in a new anaerobic digester

If the sludge is treated in a new anaerobic digester, corresponding project emissions should account for fugitive emissions of methane from the digester, and for methane emissions due to incomplete combustion of biogas in flaring equipment. Emissions from incomplete combustion of biogas in heat/electricity production equipment, if any, are considered negligible. Furthermore, since the residues from the anaerobic digester after treatment are dehydrated, limed and stored before final disposal in a controlled landfill, it is assumed that emissions of methane are negligible and need not be accounted for. Therefore, the following emissions result:

$$PE_{CH4,sl,y} = PE_{CH4,digest,y} + PE_{CH4,flare,y} \quad \textbf{(29)}$$

Where:

$PE_{CH4,sl,y}$	=	Methane emissions from treatment of sludge in the project activity in year y (tCO_2e/year)
$PE_{CH4,digest,y}$	=	Project emissions from physical leakage of methane from the anaerobic digester (tCO_2e/year)
$PE_{CH4,flare,y}$	=	Methane emissions due to incomplete combustion of biogas in flaring equipment (tCO_2e/year)

[5] For uncategorized solid waste disposal sites, the IPCC prescribes an MCF equal to 0.6. For conservativeness reasons, the value 1.0 should be used instead in this methodology.

Project emissions related to physical leakage of methane from the digester ($PE_{CH4,digest,y}$)

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/year)
$F_{biogas,y}$	=	Amount of biogas collected in the outlet of the new digester in year *y* (m^3)
$FL_{biogas,digest}$	=	Fraction of biogas that leaks from the digester. Use default IPCC value of 0.05 m^3 biogas leaked / m^3 biogas produced (2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 5, Chapter 4, Page 4.4) (m^3 biogas leaked / m^3 biogas produced)[6]
$w_{CH4,biogas,y}$	=	Concentration of methane in the biogas in the outlet of the new digester ($kgCH_4/m^3$)
GWP_{CH4}	=	Global Warming Potential of methane valid for the commitment period (tCO_2e/tCH_4)

Project emissions from incomplete combustion of biogas in flaring equipment ($PE_{CH4,flare,y}$)

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 ($PE_{CH4,flare,y}$), apply the latest approved version of the "Tool to determine project emissions from flaring gases containing methane".

N_2O emissions from treatment of sludge in the project activity in year y ($PE_{N2O,sl,y}$)

Nitrous oxide emissions from sludge treatment should be taken into account depending on the treatment method.

Calculation of $PE_{N2O,sl,y}$ if the sludge is dried or treated in a new anaerobic digester

Nitrous oxide emissions are assumed to be negligible and need not be accounted for if the sludge is:

- Dried under controlled and aerobic conditions, and then disposed to a landfill; or,
- Treated in a new anaerobic digester and the residues from the anaerobic digester are dehydrated, limed and stored before final disposal in a controlled landfill.

Therefore:

$$PE_{N2O,sl,y} = 0 \quad \textbf{(31)}$$

[6] Where project participants wish to use lower values of physical leakage, they should request for revision of the methodology with the procedure to monitor the methane leak from the digester.

Calculation of $PE_{N2O,sl,y}$ if the sludge is applied to land, dumped or left to decay

If the sludge is dumped, left to decay or applied to land, corresponding nitrous oxide emissions should be calculated as:

$$PE_{N2O,sl,y} = Q_{PJ,sl,land,y} \times w_{N,sl,y} \times EF_{N2O,sl,land} \times GWP_{N2O} \quad \textbf{(32)}$$

Where:

$PE_{N2O,sl,y}$	=	Project emissions from land application of sludge in year y (tCO_2e/year)
$Q_{PJ,sl,land,y}$	=	Amount of sludge applied to land in year y (t sludge)
$w_{N,sl,y}$	=	Mass fraction of nitrogen in the sludge applied to land in year y (t N/t sludge)
$EF_{N2O,sl,land}$	=	N_2O emission factor from sludge applied to land. The average emission factor to be used is 0.016 tN_2O/tN [7]
GWP_{N2O}	=	Global Warming Potential of nitrous dioxide (tCO_2e/tN_2O)

Project emissions from electricity consumption and combustion of fossil fuels ($PE_{EC,y}$ and $PE_{FC,y}$)

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 in the project activity, corresponding emissions are zero. However, when calculating $EG_{PJ,y}$, which is used for the calculation of baseline emissions, the electricity consumption for the operation of the project activity should be subtracted from the total on-site electricity generation with biogas (i.e., $EG_{PJ,y}$ only includes the *net* electricity generation resulting from the project activity).

If electricity is purchased from the grid and/or generated in an on-site captive power plant using fossil fuels, the latest approved version of the "Tool to calculate baseline, project and/or leakage 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".

Project emissions from transportation of sludge ($PE_{TR,sl,y}$)

The project emissions resulting from transportation of final sludge produced in the project activity should be calculated as:

$$PE_{TR,sl,y} = \sum_i N_{PJ,i,y} \times D_{PJ,i,y} \times F_{PJ,i,y} \times NCV_{PJ,j,y} \times EF_{PJ,j,y} \quad \textbf{(33)}$$

[7] 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 N2O-N / kg N (= 0.016 kg N_2O/kg N).

Where:

$PE_{TR,sl,y}$	=	CO_2 emissions associated with transportation of sludge in the project activity in year *y* (tCO_2/year)
$N_{PJ,i,y}$	=	Number of trips (vehicle of type *i* with similar loading capacity) for transportation of the sludge produced in the project activity in the year *y* (trips)
$D_{PJ,i,y}$	=	Average distance per trip travelled by the transportation vehicle of type *i* for transportation of sludge generated by the wastewater treatment system in the project activity in the year *y* (km)
$F_{PJ,i,y}$	=	Specific fuel consumption of the transportation vehicle of type *i* in the year *y* (mass or volume units of fuel/km)
$NCV_{PJ,j,y}$	=	Net calorific value of the transportation fuel *j* in the year *y* (TJ/mass or volume units)
$EF_{PJ,j,y}$	=	CO_2 emission factor of the transportation fuel *j* in the year *y* (tCO_2/TJ)
i	=	Type of vehicle
j	=	Type of fuel used in vehicles
y	=	Year of the crediting period

If the emissions associated with transportation of sludge in the baseline scenario and in the project scenario are found to be comparable (i.e., within +1% range) or emissions in the project scenario are lower, then both can be excluded in the calculation of baseline emissions and project emissions as a simplification.

Determination of $N_{PJ,i,y}$

The number of trips of the transportation vehicle of type i is calculated as:

$$N_{PJ,i,y} = \frac{Q_{PJ,sl,y}}{q_{PJ,i}} \tag{34}$$

Where:

$N_{PJ,i,y}$	=	Number of trips (vehicle of type *i* with similar loading capacity) for transportation of the sludge produced in the project activity in the year *y* (trips)
$Q_{PJ,sl,y}$	=	Quantity of sludge produced in the project activity in the year *y* (tonnes)
$q_{PJ,i}$	=	Average vehicular capacity of the transportation vehicle of type *i* (tonnes/trip)

Leakage

No leakage is considered in this methodology.

$$LE_y = 0 \tag{35}$$

Emission Reductions

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

$$ER_y = BE_y - PE_y - LE_y \tag{36}$$

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)
LE_y	=	Leakage 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 all tools to which this methodology refers applies.

Parameter:	GWP_{CH4}
Data unit:	tCO2e/tCH4
Description:	Global warming potential for CH4
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:	tCO2e/tCH4
Description:	Global warming potential for N2O
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:	B_o
Data unit:	tCH_4/tCOD
Description:	Maximum methane producing capacity of wastewater, expressing the maximum amount of CH_4 that can be produced from a given quantity of chemical oxygen demand
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. However, 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 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:	-

Parameter:	$COD_{BL,in,x}$ and $COD_{BL,out,x}$
Data unit:	tonnes of COD
Description:	Respectively, COD directed to the open lagoons in the baseline scenario in the period *x*, and COD of the effluent of open lagoons in the baseline scenario in the period *x*
Source of data:	On-site monitoring data. Refer to further details in the "Baseline emissions section"
Measurement procedures (if any):	-
Any comment:	-

Parameter:	$f_{BL,d}$
Data unit:	fraction
Description:	Factor expressing the influence of the depth of the lagoon on methane generation
Source of data:	Apply the following values for the corresponding average depth of the open lagoon: Depth > 5 m: 70% Depth 1 – 5 m: 50% Depth < 1 m: 0%
Measurement procedures (if any):	-
Any comment:	In the case the baseline scenario is identified as being a new to be built anaerobic open lagoons system, use the depth as defined in the baseline lagoon design in step 1 of the "Procedure for the identification of the most plausible baseline scenario and assessment of additionality"

Parameter:	$Q_{BL,sl,y}$
Data unit:	tonnes
Description:	Quantity of sludge that would have been produced and treated in the baseline scenario in the year *y*
Source of data:	If the baseline scenario is an existing open lagoon (W3), historical records of monthly quantity of sludge generated per unit volume of wastewater being treated in the open lagoon should be collected for one year before the implementation of the project activity. In order to ensure a conservative computation of baseline emissions, the lowest amongst the monthly values should be considered and multiplied by the quantity of wastewater treated in year *y* to estimate the sludge that would have been produced If the baseline scenario is a new to be built open lagoon (W6), the sludge quantity generated from unit volume of waste water being treated in the open lagoon should be determined for the baseline lagoon configuration as identified following the guidance provided in step 1 of the section "Procedure for the identification of the most plausible baseline scenario and assessment of additionality". The value should be then multiplied by the quantity of wastewater treated in year *y* to estimate the sludge that would have been produced

Measurement procedures (if any):	-
Any comment:	-

Parameter:	$EC_{BL,y}$
Data unit:	MWh
Description:	Annual quantity of electricity that would be consumed in the baseline scenario for the treatment of the wastewater and sludge
Source of data:	If the baseline scenario is an existing open lagoon (W3), the annual quantity of electricity that would be consumed in the baseline scenario for the treatment of the wastewater and sludge should be determined by collecting historical records of monthly electricity consumption per unit volume of wastewater treated in the open lagoon, for one year before the implementation of the project activity. In order to ensure a conservative computation of baseline emissions, the lowest amongst the monthly values should be considered and multiplied by the quantity of wastewater treated in year *y* to estimate the sludge that would have been produced If the baseline scenario is a new to be built open lagoon (W6), the annual quantity of electricity that would be consumed in the baseline scenario for the treatment of the wastewater and sludge per unit volume of wastewater treated should be determined according to the baseline lagoon design as identified in Step 1 of the section "Procedure for the identification of the most plausible baseline scenario and assessment of additionality". The value should be then multiplied by the quantity of wastewater treated in year *y* to estimate the sludge that would have been produced
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:	$EF_{CO2,FF,heat}$
Data unit:	tCO2/TJ
Description:	CO_2 emission factor of the fossil fuel used for heat generation in the baseline scenario
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:	$\eta_{BL,heat}$
Data unit:	fraction
Description:	Efficiency of the boiler that would be used for heat generation in the baseline scenario
Source of data:	See below
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. Project proponents may choose to use a conservative value of 1
Any comment:	-

Parameter:	$D_{BL,i}$
Data unit:	km
Description:	Average distance per trip, that would have been travelled by the transportation vehicle of type *i*, for transportation of sludge in the baseline scenario
Source of data:	Historical data available on-site
Measurement procedures (if any):	-
Any comment:	-

Parameter:	$F_{BL,i}$
Data unit:	mass or volume units of fuel/km
Description:	Specific fuel consumption of the transportation vehicle of type *i*
Source of data:	Historical data available on-site
Measurement procedures (if any):	-
Any comment:	-

Parameter:	$NCV_{BL,j}$ and $EF_{BL,j}$
Data unit:	Respectively: TJ/mass or volume units, and tCO_2/TJ
Description:	Respectively: net calorific value of the transportation fuel *j* , and CO_2 emission factor of the transportation fuel *j*
Source of data:	Historical data available on-site
Measurement procedures (if any):	-
Any comment:	-

Parameter:	$q_{BL,i}$
Data unit:	tonnes/trip
Description:	Average vehicular capacity of the transportation vehicle of type *i*
Source of data:	Historical data available with project proponents
Measurement procedures (if any):	-
Any comment:	-

III. MONITORING METHODOLOGY

Monitoring procedures

In addition to the data and parameters listed in the tables below, project proponents should apply the guidance and monitoring procedures defined in the tools to which this methodology refers:

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

Data and parameters monitored

Data / Parameter:	$Q_{PJ,ww,m}$ *and* $Q_{PJ,ww,i}$
Data unit:	m^3
Description:	Quantity of wastewater that is treated in the aerobic wastewater treatment plant in the project activity in month *m* and in day *i*, respectively
Source of data:	On-site measurements
Measurement procedures (if any):	-
Monitoring frequency:	Parameter monitored continuously and integrated monthly or daily for calculations
QA/QC procedures:	-
Any comment:	-

Data / Parameter:	$w_{PJ,COD,ww,m}$ *and* $w_{PJ,COD,ww,i}$
Data unit:	t COD/m^3
Description:	Average chemical oxygen demand in the wastewater that is treated in the aerobic wastewater treatment plant in the project activity in month *m* and in day *i*, respectively.
Source of data:	On-site measurements
Measurement procedures (if any):	Measure the COD according to national or international standards
Monitoring frequency:	Monitored daily. Average monthly values are used for calculations, as applicable
QA/QC procedures:	-
Any comment:	-

Data / Parameter:	$T_{2,m}$
Data unit:	K
Description:	Average temperature at the project site in month *m*
Source of data:	On-site measurements
Measurement procedures (if any):	-
Monitoring frequency:	Continuously, aggregated in monthly average values
QA/QC procedures:	-
Any comment:	-

Data / Parameter:	$EG_{PJ,y}$
Data unit:	MWh
Description:	Net quantity of electricity generated in year *y* with biogas from the new anaerobic biodigester, if applicable
Source of data:	On-site measurements
Measurement procedures (if any):	-
Monitoring frequency:	Monitored continuously and integrated over year *y* for calculations
QA/QC procedures:	-
Any comment:	-

Data / Parameter:	$HG_{PJ,y}$
Data unit:	TJ
Description:	Net quantity of heat generated in year *y* with biogas from the new anaerobic digester
Source of data:	On-site measurements of heat flow preferably at the demand side
Measurement procedures (if any):	-
Monitoring frequency:	Monitored daily
QA/QC procedures:	-
Any comment:	-

Data / Parameter:	$Q_{PJ,effl,i}$ and $Q_{PJ,effl,m}$
Data unit:	m^3
Description:	Quantity of effluent that leaves the aerobic wastewater treatment plant in the project activity in day *i* and month *m*, respectively.
Source of data:	On-site measurements
Measurement procedures (if any):	-
Monitoring frequency:	Parameter monitored continuously and aggregated daily and monthly for calculations
QA/QC procedures:	-
Any comment:	-

Data / Parameter:	$w_{PJ,COD,effl,i}$ and $w_{PJ,COD,effl,m}$
Data unit:	t COD/m³
Description:	Average chemical oxygen demand in the effluent that leaves the aerobic wastewater treatment plant in the project activity in day *i* and month *m*, respectively
Source of data:	On-site measurements
Measurement procedures (if any):	Measure the COD according to national or international standards
Monitoring frequency:	Monitored daily. Average monthly values are used for calculations, as applicable
QA/QC procedures:	-
Any comment:	-

Data / Parameter:	$f_{PJ,d,y}$
Data unit:	fraction
Description:	Factor expressing the influence of the depth on methane generation in year *y*
Source of data:	Apply the following values for the corresponding average depth: Depth > 5 m: 70% Depth 1 – 5 m: 50% Depth < 1 m: 0%
Measurement procedures (if any):	Conduct monthly measurements of depth under normal operating conditions and take the annual average value for calculations
Monitoring frequency:	-
QA/QC procedures:	-
Any comment:	-

Data / Parameter:	$Q_{PJ,sl,y}$
Data unit:	tonnes
Description:	Quantity of sludge produced in the project activity in the year *y*
Source of data:	On-site measurements
Measurement procedures (if any):	-
Monitoring frequency:	Parameter monitored continuously or in batches, as applicable, and aggregated yearly for calculations
QA/QC procedures:	-
Any comment:	-

Data / Parameter:	$F_{biogas,y}$
Data unit:	m^3
Description:	Amount of biogas collected in the outlet of the new digester in year *y*
Source of data:	On-site measurements
Measurement procedures (if any):	-
Monitoring frequency:	Parameter monitored continuously and aggregated annually for calculations
QA/QC procedures:	Flow meters will undergo maintenance/calibration subject to appropriate industry standards, according to each application. This maintenance/calibration practice should be clearly stated in the CDM-PDD
Any comment:	-

Data / Parameter:	$w_{CH4,biogas,y}$
Data unit:	kg CH_4 / m^3
Description:	Concentration of methane in the biogas in the outlet of the new digester
Source of data:	On-site measurements
Measurement procedures (if any):	Using calibrated continuous gas analyser
Monitoring frequency:	Either with continuous analyser or alternatively with periodical measurement. Take the higher bound of a confidence interval with 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:	$Q_{PJ,sl,land,y}$
Data unit:	tonnes
Description:	Amount of sludge applied to land in year *y*
Source of data:	On-site measurements
Measurement procedures (if any):	-
Monitoring frequency:	Parameter monitored continuously or in batches, as applicable, and aggregated yearly for calculations
QA/QC procedures:	-
Any comment:	-

Data / Parameter:	$w_{N,sl,y}$
Data unit:	t N / t sludge
Description:	Mass fraction of nitrogen in the sludge applied to land in year *y*
Source of data:	On-site measurements
Measurement procedures (if any):	Measure the N content according to national or international standards
Monitoring frequency:	Regularly, following $Q_{PJ,sl,land,y}$ monitoring frequency. The average yearly value is used for calculations
QA/QC procedures:	-
Any comment:	-

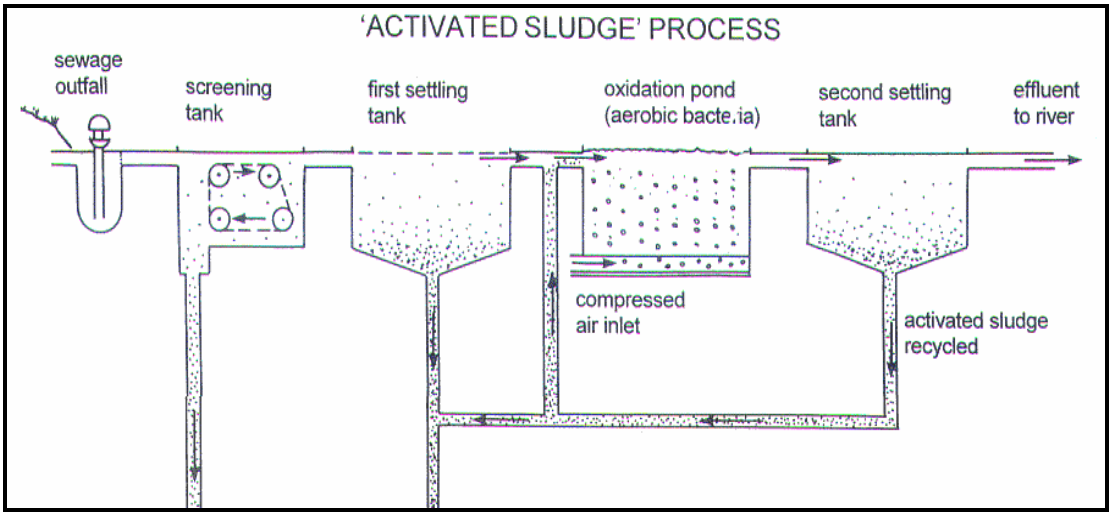
Data / Parameter:	$D_{PJ,i,y}$
Data unit:	km
Description:	Average distance per trip travelled by the transportation vehicle of type *i* for transportation of sludge generated by the wastewater treatment system in the project activity in the year *y*
Source of data:	On-site measurements
Measurement procedures (if any):	-
Monitoring frequency:	-
QA/QC procedures:	-
Any comment:	-

Data / Parameter:	$F_{PJ,i}$
Data unit:	mass or volume units of fuel/km
Description:	Specific fuel consumption of the transportation vehicle of type *i*
Source of data:	On-site measurements
Measurement procedures (if any):	-
Monitoring frequency:	-
QA/QC procedures:	-
Any comment:	-

Data / Parameter:	$NCV_{PJ,j,y}$ and $EF_{PJ,j,y}$
Data unit:	Respectively: TJ/mass or volume units, and tCO_2/TJ
Description:	Respectively: net calorific value of the transportation fuel *j* , and CO_2 emission factor of the transportation fuel *j* in the year *y*
Source of data:	On-site measurements
Measurement procedures (if any):	-
Monitoring frequency:	-
QA/QC procedures:	-
Any comment:	-

Data / Parameter:	$q_{PJ,i}$
Data unit:	tonnes/trip
Description:	Average vehicular capacity of the transportation vehicle of type *i*
Source of data:	On-site measurements
Measurement procedures (if any):	-
Monitoring frequency:	-
QA/QC procedures:	-
Any comment:	-

Annex 1 - Aerobic Wastewater Treatment System



Sludge Sludge

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History of the document

Version	Date	Nature of revision(s)
01	EB 47, Annex 2 28 May 2009	Initial adoption.