Draft revision to the approved consolidated baseline and monitoring methodology ACM0014

“Treatment of wastewater”

I. SOURCE, DEFINITIONS AND APPLICABILITY

Sources

This consolidated baseline and monitoring methodology is based on elements from the following approved baseline and monitoring methodologies and proposed new methodologies:

- 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;
- AM0013: Avoided methane emissions from organic waste-water treatment - Version 04;
- AM0022: Avoided Wastewater and On-site Energy Use Emissions in the Industrial Sector - Version 04.

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

- “Tool for the demonstration and assessment of additionality”;
- “Tool to calculate the emission factor for an electricity system”;
- ”Project and leakage emissions from anaerobic digesters”;
- “Tool to determine the baseline efficiency of thermal or electric energy generation systems”;
- “Assessment of the validity of the original/current baseline and update of the baseline at the renewal of the crediting period”.

For more information regarding the proposed new methodologies and the tools as well as their consideration by the CDM Executive Board (the Board) please refer to <http://cdm.unfccc.int/methodologies/PAmethodologies/index.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. Equipment that is used to generate biogas from liquid and/or solid waste through anaerobic digestion. The digester is covered or encapsulated to enable biogas capture for flaring, heat and/or power generation or feeding biogas into a natural gas network. The following types of digesters are considered:

- Covered anaerobic lagoons: anaerobic lagoons that are covered with a flexible membrane to capture methane produced during the digestion process. Covered anaerobic lagoons are typically used for high volume effluent such as animal manure and organic industrial effluent like starch industry effluent;
- Conventional digesters: digesters that are operated similar to a covered anaerobic lagoon, with no mixing or liquid and biogas recirculation;
- High rate digesters, such as upflow anaerobic sludge blanket (UASB) reactors, anaerobic filter bed reactors and fluidized bed reactors; and
- Two stage digesters: anaerobic digestion takes place in a two stage process, solubilization of particulate matter occurs and volatile acids are formed in the first stage digester. The second stage is carried out in a separate digester, at a neutral pH and a longer solid retention time.

Anaerobic lagoon. A treatment system consisting of a deep earthen basin with sufficient volume to permit sedimentation of settable solids, to digest retained sludge, and to anaerobically reduce some of the soluble organic substrate. Anaerobic lagoons are not aerated, heated, or mixed anaerobic conditions prevail except for a shallow surface layer in which excess undigested grease and scum are concentrated.

Solid materials. Suspended fine solids, non dissolved, that are mechanically separated (e.g. through a centrifuge) from the wastewater stream of a process in order to be treated separately[1]. The solid materials shall have a dry matter content equal to or higher than 20% on mass basis. Furthermore, materials resulting from the gravity settling or the chemical (pre-treatment) of the wastewater are not considered as solid materials under this methodology.

[1] Releasing these suspended fine solids directly into open lagoons, along with the wastewater, generally leads to higher amount of sludge formation and hence the lagoons require regular de-sludging. In such cases the solids can be separated and treated differently to reduce required de-sludging of lagoons.

Applicability

This methodology is applicable to project activities that reduce methane emissions from wastewater treatment. The methodology is applicable to the scenarios described in Table 1.[2]

Table 1: Scenarios applicable to the methodology

Scenario	Description of the baseline scenario	Description of the project activity
1	The wastewater is not treated, but directed to open lagoons that have clearly anaerobic conditions. In cases where solid materials are separated before directing the wastewater to the open lagoons, the solid materials have a different treatment than the wastewater.	The wastewater is either treated in a new anaerobic digester or dewatered and directed to land application. In cases where solid materials are separated from the wastewater (both in the project and baseline scenarios), they will be treated separately and not treated with the new anaerobic digester employed for treatment of liquid effluents. The biogas extracted from the anaerobic digester and, if applicable, biogas[3] generated from the treatment of solid materials, 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 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 scenario. 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)

Project participants should document in the CDM-PDD which scenario applies and clearly describe the situation in the baseline scenario and in the project activity, preferably by providing similar diagrams as contained in Appendix 1, which provides an example of Scenario 2. The methodology is applicable under the following conditions:

- The average depth of the open lagoons or sludge pits in the baseline scenario is at least 1m;[4]
- The residence time of the organic matter in the open lagoon system should be at least 30 days;[5]

[2] 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.

[3] Emission reductions are not claimed for both methane avoidance and biogas use from the solid materials.

[4] 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”.

- Inclusion of solid materials in the project activity is only applicable where: (i) Such solid materials are generated by the facility producing the wastewater, and (ii) The solid materials would be generated both in the project and in the baseline scenario.
- 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.

In addition, the applicability conditions included in the tools referred to above apply.

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/dewatered wastewater is applied to lands;
- Any on-site power plants that supply electricity to the wastewater or sludge treatment system;
- 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 anaerobic 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".

[5] 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".

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	Main source of emissions
		N_2O	Excluded	Excluded for simplification
		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
		CH_4	Excluded	Excluded for simplification
		N_2O	Excluded	Excluded for simplification
	Thermal energy generation	CO_2	Included	On-site thermal energy generation could be displaced by the project activity
		CH_4	Excluded	Excluded for simplification
		N_2O	Excluded	Excluded for simplification
Project Activity	Wastewater treatment processes or sludge treatment process	CH_4	Included	Main source of emissions
		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
		CH_4	Excluded	Excluded for simplification
		N_2O	Excluded	Excluded for simplification
	On-site fossil fuel consumption	CO_2	Included	May be an important emission source
		CH_4	Excluded	Excluded for simplification
		N_2O	Excluded	Excluded for simplification

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 wastewater is treated in anaerobic digester or applied after dewatering, 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 wastewater to a 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;

W6: Wastewater is directed to land application without dewatering;

W7: Wastewater is dewatered and directed to land application/used as fuel in energy applications.

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

(1) 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 (D) and surface area of the lagoon, electricity consumption (EC_{BL}), retention time of the organic matter and effluent flows ($COD_{out,x}$ and $COD_{in,x}$), 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;

(2) 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 above taking into account all relevant local conditions (e.g. land requirements, land prices, ground water level). If several options with the same low costs are identified, choose the one with the lowest lagoon depth as the baseline lagoon design.

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.

In case of Scenario 1, plausible alternative scenarios for the treatment of solid materials (SM), if applicable, should be determined. These may include, but not limited to, the following:

SM1: The solid materials are dumped or left to decay under anaerobic or aerobic conditions;

SM2: The solid materials are used as animal fodder;

SM3: The solid materials are burnt in an uncontrolled manner without utilizing it for energy purposes;

SM4: The solid materials are burnt for energy purposes.

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), the generation of heat (H) and the solid materials (SM). 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 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 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 costs;
- Engineering, procurement and construction costs;
- Labour costs;
- Operation and Maintenance costs;
- Administration costs;
- Fuel costs;
- Revenue from electricity sales;
- All other costs of implementing the technology of each alternative option;

- All revenues generated by the implementation of the proposed technology except for CDM benefits. Revenues could include energy savings due to captive use of biogas as fuel for either electricity or heat generation at the project site, revenue on account of avoided water consumption, fossil fuel replacement, sale of concentrated solids as fertilizers, etc.

In the case that there are several alternatives remaining after Step 2 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 Board.

In case the sensitivity analysis is not fully conclusive, select the baseline scenario alternative with the lowest emissions among the alternatives that are the most economically attractive.

In case that the only remaining alternative is the CDM project undertaken without being registered as a CDM project activity, 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, H1/H2 for heat production and SM1/SM2/SM3 for the solid materials;
- For Scenario 2: W1 or W3 for the treatment of wastewater, S1 for the use of the sludge and, if applicable, E1/E2 for the generation of electricity and H1/H2 for heat production.

Additionality

Use the latest version of the "Tool for the demonstration and assessment of additionality" agreed by the 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 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:

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

Where:

BE_y	=	Baseline emissions in year *y* (tCO_2e/yr)
$BE_{CH4,y}$	=	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) in the absence of the project activity in year *y* (tCO_2e/yr)
$BE_{EL,y}$	=	Baseline 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)

$BE_{HG,y}$ = Baseline 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 to use the minimum value between the methane produced after the implementation of the project activity and methane conversion factor method for the estimation of methane emissions from open lagoons in case of the waste water lagoons and sludge in sludge pits.

$$BE_{CH4,y} = \min\{Q_{CH4,y} \quad ; \quad BE_{CH4,MCF,y}\} \qquad \textbf{(2)}$$

Where:

$BE_{CH4,y}$ = 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) in the absence of the project activity in year *y* (tCO_2e/yr)

$Q_{CH4,y}$ = Methane produced in year y after the implementation of the project activity (tCO_2e/y)

$BE_{CH4,MCF,y}$ = Baseline methane emissions using the Methane Conversion Factor (tCO_2e/y)

a) Methane produced ($Q_{CH4,y}$)

Projects proponent shall use Step 1" Determination of the quantity of methane produced in the digester ($Q_{CH4,y}$)"of the latest version of the tool "Project and leakage emissions from anaerobic digesters" to determine the amount of methane produced after the implementation of the project activity ($Q_{CH4,y}$).

b) Methane conversion factor ($BE_{CH4,MCF,y}$)

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 ($COD_{BL,y}$), the maximum methane producing capacity (B_o) and a methane conversion factor ($MCF_{BL,y}$) which expresses the proportion of the wastewater that would decay to methane, as follows:

$$BE_{CH4,MCF,y} = GWP_{CH4} \times MCF_{BL,y} \times B_o \times COD_{BL,y} \qquad \textbf{(3)}$$

Where:

$BE_{CH4,MCF,y}$	=	Baseline methane emissions using the Methane Conversion Factor (tCO_2e/y)
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 ($COD_{BL,y}$ 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 ($COD_{PJ,y}$). But, if there would be effluent from the lagoons (Scenario 1) or the sludge pit (Scenario 2) in the baseline, COD_{BL} should be adjusted by an adjustment factor which relates the COD supplied to the lagoon or sludge pit with the COD in the effluent.

$$COD_{BL,y} = \rho\left(1 - \frac{COD_{out,x}}{COD_{in,x}}\right) \times COD_{PJ,y} \quad \textbf{(4)}$$

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)
$COD_{out,x}$	=	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
ρ	=	Discount factor for historical information

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

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

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 anaerobic conditions in the project activity in month *m* (m^3/month)
$COD_{dig,m}$	=	Chemical oxygen demand in the wastewater or sludge that is treated in the anaerobic digester or under clearly anaerobic 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 uncertainty associated with this approach. $MCF_{BL,y}$ is calculated as follows:

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

Where:

$MCF_{BL,y}$	=	Average baseline methane conversion factor (fraction) in year *y*, representing the fraction of ($COD_{BL,y}$ 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 fd

f_d represents the influence of the average depth of the lagoons or sludge pit on methane generation.

$$f_d = \begin{cases} 0\,; & if\ D < 1m \\ 0.5; & if\ 1\,m \le D < 2\,m \\ 0.7; & if\ D \ge 2\,m \end{cases} \quad (7)$$

Where

f_d	=	Factor expressing the influence of the depth of the lagoon or sludge pit on methane generation
D	=	Average depth of the lagoons or sludge pits (m)

Determination of $f_{T,y}$

An increase in temperature in the lagoon has several benefits to generate more methane, including an increasing solubility of the organic compounds, enhanced biological and chemical reaction rates. 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:

$$COD_{available,m} = COD_{BL,m} + (1 - f_{T,m}) \times COD_{available,m-1} \text{ with} \quad \textbf{(8)}$$

$$COD_{BL,m} = \left(1 - \frac{COD_{out,x}}{COD_{in,x}}\right) \times COD_{PJ,m} \text{ and} \tag{9}$$

$$COD_{PJ,m} = F_{PJ,dig,m} \times COD_{dig,m} \tag{10}$$

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)
$F_{PJ,dig,m}$	=	Quantity of wastewater or sludge that is treated in the anaerobic digester or under clearly anaerobic conditions in the project activity in month *m* (m^3/month)
$COD_{dig,m}$	=	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-1*
m	=	Months of year *y* of the crediting period
$COD_{out,x}$	=	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

In case of emptying the lagoon or 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. 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:

$$f_{T,m} = \begin{cases} 0 & if \quad T_{2,m} < 283K \\ e^{\left(\frac{E*(T_{2,m}-T_1)}{R*T_1*T_{2,m}}\right)} & if \quad 283K \leq T_{2,m} \leq 303K \\ 1 & if \quad T_{2,m} > 303K \end{cases} \tag{11}$$

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

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

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

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 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:

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

Where:

$BE_{EL,y}$	=	CO_2 emissions associated with electricity generation that is displaced by the project activity and/or electricity consumption in the 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)

<u>Determination of $EF_{BL,EL,y}$</u>

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 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*.

$$EF_{BL,EL,y} = EF_{grid,y} \quad \textbf{(14)}$$

In the case baseline scenario is E1, the lower emission factor between the grid emission factor and the emission factor of a captive power plant should be used as a conservative approach.

$$EF_{BL,EL,y} = MIN\left(EF_{grid,y};0.8\right) \quad \textbf{(15)}$$

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)

$EF_{grid,y}$ Shall be calculated using the latest version of the “Tool to calculate the emission factor for an electricity system” The emission factor of 0.8 tCO_2/MWh represents the case of producing electricity using a diesel engine

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:

$$BE_{HG,y} = \frac{HG_{PJ,y} \times EF_{CO2,FF,boiler}}{\eta_{BL,boiler}} \quad \textbf{(16)}$$

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 (GJ)
$EF_{CO2,FF,boiler}$	=	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/GJ)
$\eta_{BL,boiler}$	=	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.

Determination of $EF_{CO2,FF,boiler}$

For existing facilities.

- Project participants should choose the fossil fuel with the lowest emission factor that was used in the facility that generates de wastewater for heating purposes before the implementation of the project activity the year prior the implementation of the project activity.

For Greenfield facilities.

- Project participants shall use natural gas as the baseline fossil fuel, if this resource is available in the region, otherwise;
- Project participants should identify what is the most common fuel used in similar facilities and use it as baseline fuel. Detailed justifications shall be provided and documented in the CDM-PDD for the selected baseline fuel.

Determination of $\eta_{BL,boiler}$

Project participants should use the latest version of the "Tool to determine the baseline efficiency of thermal or electric energy generation systems" to determine the efficiency of the boiler. Parameter $\eta_{BL,boiler}$ corresponds to parameter η in the tool.

Project emissions

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

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

(b) In the case of project activities that introduce a treatment of sludge or land application of wastewater. Methane and nitrous oxide emissions from land application of sludge should be estimated ;

(c) In the case of project activities where wastewater is dewatered and directed to land application. Methane and nitrous oxide emissions from land application of wastewater should be estimated.

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

(i) Project emissions from land application of sludge

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

$$\mathrm{PE}_{\mathrm{sludge,LA,y}} = COD_{sludge,LA,y} \times B_o \times MCF_{sludge,LA} \times GWP_{CH4} + N_{sludge,LA,y} \times EF_{N2O,LA,sludge} \times \mathrm{GWP}_{\mathrm{N2O}} \quad \mathbf{(17)}$$

with

$$\mathrm{COD}_{\mathrm{sludge,LA,y}} = \sum_{m=1}^{12} \mathrm{S}_{\mathrm{LA,m}} \times \mathrm{w}_{\mathrm{sludge,COD,LA,m}} \text{ and} \quad \mathbf{(18)}$$

$$N_{sludge,LA,y} = \sum_{m=1}^{12} S_{LA,m} \times w_{N,sludge,m} \quad \textbf{(19)}$$

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)
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 ($tCH_4/tCOD$)
$MCF_{sludge,LA}$	=	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)
$w_{sludge,COD,LA,m}$	=	Average chemical oxygen demand in the the sludge applied to land after the dewatering process in month *m* (t COD/t sludge)
$S_{LA,m}$	=	Amount of sludge applied to land in month *m* (t sludge/month)
$N_{sludge,LA,y}$	=	Amount of nitrogen in the sludge applied to land in year *y* (t N/yr)
$w_{N,sludge,m}$	=	Mass fraction of nitrogen in the sludge applied to land in month *m* (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)

(ii) Project emissions from land application of wastewater

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

$$PE_{y} = COD_{ww,LA,y} \times B_o \times MCF_{ww,LA} \times GWP_{CH4} + N_{ww,LA,y} \times EF_{N2O,LA,ww} \times GWP_{N2O} \quad \textbf{(20)}$$

with

$$COD_{ww,LA,y} = \sum_{m=1}^{12} DWW_{LA,m} \times w_{ww,COD,LA,m} \quad \text{and} \quad \textbf{(21)}$$

$$N_{ww,LA,y} = \sum_{m=1}^{12} DWW_{LA,m} \times w_{N,ww,m} \quad \textbf{(22)}$$

Where:

PE_y	=	Project emissions in year *y* (tCO_2e/yr)
$COD_{ww,LA,y}$	=	Chemical oxygen demand (COD) of the wastewater applied to land after the dewatering process in year *y* (tCOD/yr)
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 ($tCH_4/tCOD$)
$MCF_{ww,LA}$	=	Methane conversion factor for the application of wastewater to lands
GWP_{CH4}	=	Global Warming Potential of methane valid for the applicable commitment period (tCO_2e/tCH_4)

$W_{ww,COD,LA,m}$	=	Chemical oxygen demand in the dewatered wastewater in month *m* (t COD/t dewatered wastewater)
$DWW_{LA,m}$	=	Amount of dewatered wastewater applied to land in month *m* (t/month)
$N_{ww,LA,y}$	=	Amount of nitrogen in wastewater applied to land in year *y* (t N/yr)
$w_{N,ww,m}$	=	Mass fraction of nitrogen in the wastewater applied to land in month *m* (t N/t dewatered wastewater)
$EF_{N2O,LA,ww}$	=	N_2O emission factor for nitrogen from wastewater applied to land (t N_2O/t N)
GWP_{N2O}	=	Global Warming Potential of nitrous dioxide (tCO_2e/tN_2O)

Leakage emissions

In the case of project activities that introduce an anaerobic digester for the treatment of wastewater, solid materials or sludge. use the latest approved version of the tool "Project and leakage emissions from anaerobic digesters" to calculate leakage emissions. Where LE_y is equivalent to $LE_{AD,y}$ in the tool.

Additionally leakage emissions are also calculated for Scenario 1 type projects that include the treatment of solid materials in the digester in the project activity, and identified baseline scenario for the treatment of solid materials in the "Procedure for the identification of the most plausible baseline scenario" is SM2: The solid materials are used as animal fodder.

In such case, the potential source of leakage emission is the CO_2 emissions related to the production of additional animal fodder (or feed) that would be required in the project scenario due to the diversion of solid materials that were used as animal fodder in the baseline scenario, as a result of the project activity.

For this purpose, project participants shall assess the supply situation for the types of solid materials (suitable for animal fodder) in the region. Project participants may, however, rule out the leakage emissions, if they demonstrate that the use of the solid materials in the project activity does not result in CO_2 emissions elsewhere for the production of additional animal fodder, by one of the options below:

L_1: Demonstrate that there is an abundant surplus of the solid materials in the region of the project activity which are not utilized. For this purpose, demonstrate that the quantity of available solid materials in the region is at least 25% larger than the quantity that is utilized for animal fodder;

L_2: Demonstrate that suppliers of the solid materials in the region of the project activity are not able to sell all of their solid materials. For this purpose, project participants shall demonstrate that both project entity as well as a representative sample of producers of the same type of solid materials in the region, had a surplus of these solid materials (e.g. at the end of the period during which solid materials are sold), which they could not sell and which is not utilized.

When project participants wish to use approaches L1 or L2 to rule out leakage emissions, they shall clearly define the geographical boundary of the region and document it in the CDM-PDD. In defining the geographical boundary of the region, project participants should take the usual distances for animal fodder transports into account, i.e. if animal fodder is transported up to 50 km, the region may cover a radius of 50 km around the project activity. In any case, the region should cover a radius around the project activity of at least 20 km but not more than 200 km.

If project participants are not able to rule out the leakage emissions using one of the approaches above, a leakage penalty shall be applied. This leakage penalty shall be calculated for each year *y* as follows:

$$LE_y = \sum_k EF_{CO2,k,LE} \times SM_{PJ,k,y} \times NCV_k \quad \text{and} \tag{23}$$

$$EF_{CO2,k,LE} = \sum_i f_i \times EF_i \tag{24}$$

Where:

LE_y	=	Leakage emissions during the year y (tCO_2/yr)
$EF_{CO2,k,LE}$	=	CO_2 emission factor of production of animal fodder that is used to replace the solid materials type k (tCO_2/GJ)
$SM_{PJ,k,y}$	=	Quantity of solid materials type k that are displaced as animal fodder as a result of the project activity during the year y (tons of dry matter)
k	=	Types of solid materials for which leakage effects could not be ruled out with one of the approaches L1 or L2 above
NCV_k	=	Net calorific value of the solid materials type k (GJ/ton)
f_i	=	Fraction of total calorific value of animal feed type i, compared to the total calorific value of all animal feed, which is used to replace the solid materials (%)
EF_i	=	Specific production emission factor of type of animal feed i which is used to replace the solid materials (tCO_2/GJ)
i	=	Types of different animal feeds which are used to replace the solid materials

Alternatively, given the potential complexity of the above procedure, the leakage penalty may be calculated by applying a simple yet conservative alternative:

$$LE_y = K_{SM} \times \sum_k SM_{PJ,k,y} \tag{25}$$

Where:

LE_y	=	Leakage emissions during the year y (tCO_2/yr)
$SM_{PJ,k,y}$	=	Quantity of solid materials type k that are displaced as animal fodder as a result of the project activity during the year y (tons of dry matter)
K_{SM}	=	Default value of 1 tCO_2 / ton of dry matter

Note that the default value can only be used in case the production of animal fodder in the region does not have an impact on deforestation. In case deforestation is likely to occur, this needs be included and a region specific emission factor for animal fodder production needs to be estimated according to formula 17.

Emission Reductions

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

$$ER_y = BE_y - PE_y - LE_y \tag{26}$$

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

Project participants shall use the latest version of the tool "Assessment of the validity of the original/current baseline and update of the baseline at the renewal of the crediting period" to assess the continued validity of the baseline and to update the baseline at the renewal of a crediting period.

Project activity under a programme of activities

In addition to the requirements set out in the latest approved version of the "Standard for demonstration of additionality, development of eligibility criteria and application of multiple methodologies for programme of activities", the following shall be applied for the use of this methodology in a project activity under a programme of activities (PoAs).

The PoA may consist of one or several types of CPAs. CPAs are regarded to be of the same type if they are similar with regard to the demonstration of additionality, emission reduction calculations and monitoring. The CME shall describe in the CDM-PoA-DD for each type of CPAs separately:

(a) Eligibility criteria for CPA inclusion used for each type of CPAs. In case of combinations of the types of use of the captured biogas in one CPA, the eligibility criteria shall be defined for each type of use of biogas separately;

(b) Emission reduction calculations for each type of CPAs;

(c) Monitoring provisions for each type of CPAs.

The CME shall describe transparently and justify in the CDM-PoA-DD which CPAs are regarded to be of the same type. CPAs shall not be regarded to be of the same type if one of the following conditions is different:

(a) The baseline scenario with regard to any of the following aspects:
    (i) Use of open lagoons with anaerobic conditions for wastewater treatment;
        - Treatment options for solid materials;
    (ii) Use of anaerobic wastewater treatment facilities. Sludge is generated from primary and/or secondary settlers and directed to sludge pits with anaerobic conditions;

(b) The project activity with regard to any of the following aspects:

1. The project activity is wastewater treatment with an anaerobic digester.

(a) The captured biogas is used for in one of the following ways:
    (i) Flaring;
    (ii) Heat generation;
    (iii) Electricity generation;
    (iv) Feeding biogas into a natural gas network;
    (v) Combinations of any of the above;

(b) The residual sludge from the anaerobic digester is directed to:
    (i) Open lagoons;
    (ii) Dewatering and land application.

2. Wastewater is treated at the wastewater treatment facilities of a wastewater treatment plant.

(a) The sludge generated from primary and/or secondary settlers is treated in the following ways:

(b) The sludge is treated in a new anaerobic digester that enables the use of captured biogas for:

(i) Flaring;

(ii) Heat generation;

(iii) Electricity generation;

(iv) Feeding biogas into a natural gas network;

(v) Combination of any of the above;

(c) The residual sludge from the digester is directed to:

(i) Open lagoons;

(ii) Dewatering and land application.

(d) The sludge is treated under aerobic conditions through wastewater dewatering and directing to land application;

(i) The legal and regulatory framework

(ii) Type of wastewater (e.g., COD ranges)

(iii) Type of industry generating wastewater (e.g., pulp and paper industry, food industry, etc.

For example, one type of CPAs may be characterized by the following combinations. The baseline scenario is the use of an anaerobic lagoon for wastewater treatment. Under the project activity, an anaerobic digester is used. The biogas from the digester is used to produce heat. The residual sludge from the anaerobic digester is dewatered and applied to land. Another type of CPAs is characterized by the following combinations. The baseline scenario is the use of the anaerobic lagoon for wastewater treatment. Under the project activity, the anaerobic digester is used for wastewater treatment. The biogas from the digester is used to produce electricity. The residual sludge from the anaerobic digester is treated in open lagoons.

When defining eligibility criteria for CPA inclusion for a distinct type of CPAs, the CME shall consider relevant technical and economic parameters, such as:

(a) Ranges of design specifications of baseline and project wastewater treatment units (e.g., a range of average depths and surface areas of lagoons, electricity consumption, residence time of the organic matter and effluent adjustment factor);

(b) Local conditions (temperature);

(c) Ranges of capacity of biogas production;

(d) Ranges of costs (capital investment in Greenfield wastewater treatment facility, operating and maintenance costs, etc.);

(e) Ranges of revenues (income from electricity, heat or biogas sale, subsidies/fiscal incentives, ODA).

The eligibility criteria related to the costs and revenues parameters shall be updated every 2 years in order to correctly reflect the technical and market circumstances of a CPA implementation

In case the PoA contains several types of CPAs, the actual CPA-DD submitted for the purpose of registration of the PoA shall contain all information required as per the latest approved version of the "Guidelines for completing the component project activity design document form" for each type of actual CPA, to be validated by a DOE and submitted for the registration to the Board.

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.

Data / Parameter:	$COD_{out,x}$ $COD_{in,x}$
Data unit:	t COD
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: (a) If there is no effluent: $COD_{out,x} = 0$; (b) If there is effluent: • One year of historical data should be used , or • If one year data is not available then x represents a measurement campaign of at least 10 days to the COD inflow (CODin,x) and COD outflow (CODout,x) from the lagoon or sludge pit. For Greenfield projects: (a) 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):	For the 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)
Any comment:	-

Data / Parameter:	x
Data unit:	Time
Description:	Representative historical reference period
Source of data:	For existing plants: (a) x should represents one year of historical data; (b) If one year data is not available then x represents a measurement campaign of at least 10 days For Greenfield projects this parameter is not relevant
Measurement procedures (if any):	-
Any comment:	-

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Data / Parameter:	ρ
Data unit:	-
Description:	Discount factor for historical information
Source of data:	For existing plants: (a) If one year of historical data is available ρ=1; (b) If a measurement campaign of at least 10 days is available ρ=0.89 For Greenfield projects: ρ=1
Measurement procedures (if any):	The value of 0.89 for the case where there is no one year historical data is to account for the uncertainty range (of 30% to 50%) associated with this approach as compared to one-year historical data
Any comment:	-

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Data / 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 shall be used. Unless 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 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

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Data / Parameter:	D
Data unit:	m
Description:	Average depth of the lagoons or sludge pits
Source of data:	For existing plants: Conduct measurements For project activities implemented in Greenfield facilities: As per the baseline lagoon design as identified in Step 1 of the section "Procedure for the identification of the most plausible baseline scenario Identification of alternative scenarios"
Measurement procedures (if any):	Determine the average depths of the whole lagoon/sludge pit under normal operating conditions
Any comment:	-

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Data / 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)

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Source of data:	In case of existing plants: • Average yearly electricity consumption of the most recent three years prior to the implementation of the project activity. In case of project activities implemented in Greenfield facilities: • Technical specifications according to the baseline lagoon or sludge pit 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:	-

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Data / Parameter:	$EF_{CO2,FF,boiler}$
Data unit:	tCO_2/GJ
Description:	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 default values 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

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Data / Parameter:	$EF_{N2O,LA,sludge}$
Data unit:	$t N_2O/t N$
Description:	N_2O emission factor for nitrogen from sludge applied to land
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

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Data / Parameter:	$EF_{N2O,LA,ww}$
Data unit:	t N_2O/t N
Description:	N_2O emission factor for nitrogen from wastewater applied to land
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

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

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Data / Parameter:	$MCF_{ww,LA}$
Data unit:	-
Description:	Methane conversion factor for the application of wastewater to lands
Source of data:	-
Measurement procedures (if any):	No measurement procedures. Value to be applied 0.05
Any comment:	-

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Data / 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

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Data / 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

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Data / Parameter:	EF_i
Data unit:	tCO_2/GJ
Description:	Specific production emission factor of type of animal feed which is used to replace the solid materials
Source of data:	Use relevant emission factors based on lifecycle analysis studies, for type *i* of animal feed used to replace the solid materials (e.g. from scientific literature, industry sources or manufacturers). Alternatively, identify average lifecycle emissions per animal feed produced (e.g. calculations based on national/international statistics or estimated by external research institutes or national agencies responsible for GHG inventory)
Measurement procedures (if any):	-
Any comment:	Applicable if leakage occurs due to displacement of animal fodder. In case the production of animal fodder in the region has an impact on deforestation, emissions associated with the deforestation need to be included in the estimations

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Data / Parameter:	f_i
Data unit:	Fraction GJ/GJ (%)
Description:	Fraction of animal feed type *i* compared to the total mix of animal feed which is used to replace the solid materials on dry basis
Source of data:	Interviews with existing customers of solid materials type *k* and/or regional/national market statistics on animal feed use, which can be statistically significant (representative sampling with 95% confidence interval)
Measurement procedures (if any):	-
Any comment:	Applicable if leakage occurs due to displacement of animal fodder. In case of variation in the data, apply a conservative approach (i.e. the largest fraction for the most GHG intensive animal fodder etc.)

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Data / Parameter:	NCV_k
Data unit:	GJ/ton of dry matter
Description:	Net calorific value of the solid materials type *k*
Source of data:	Measurements shall be carried out at qualified laboratories and according to relevant national or international standards. Measure the NCV based on dry matter
Measurement procedures (if any):	-
Any comment:	Applicable if leakage occurs due to displacement of animal fodder

III. MONITORING METHODOLOGY

Describe and specify in the CDM-PDD all monitoring procedures, including the type of measurement instrumentation used, the responsibilities for monitoring and QA/QC procedures that will be applied. Where the methodology provides different options (e.g. use of default values or on-site measurements), specify which option will be used. All meters and instruments should be calibrated regularly as per industry practices.

All data collected as part of monitoring should be archived electronically and be kept at least for two years after the end of the last crediting period. One hundred percent of the data should be monitored if not indicated differently in the comments in the tables below.

In addition, the monitoring provisions in the tools referred to in this methodology apply.

Data and parameters monitored

Data / Parameter:	$F_{PJ,dig,m}$
Data unit:	m³/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 monthly and annually for calculations
QA/QC procedures:	-
Any comment:	In case of Scenario 1, if the solid materials are also treated in the baseline and project scenario, the $F_{PJ,dig,m}$ does not account the amount of solid materials treated or separated from the wastewater stream in the anaerobic digester, if applicable

Data / Parameter:	$COD_{,dig,m}$
Data unit:	T COD/m³
Description:	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. If COD is measured more than once per month, the average value of the measurements should be used
Monitoring frequency:	Regularly, calculate average monthly and annual values
QA/QC procedures:	-
Any comment:	In case of Scenario 1, if the solid materials are also treated in the baseline and project scenario, the $w_{COD,dig,m}$ is not calculated for the solid materials treated or separated from the wastewater stream in the anaerobic digester, if applicable

Data / Parameter:	$T_{2,m}$
Data unit:	K
Description:	Average temperature at the project site in month *m*
Source of data:	Measurement in the project site, or National or regional weather statistics
Measurement procedures (if any):	In case that project participants decide to measure temperature in the project site: • The temperature sensor must be housed in a ventilated radiation shield to protect the sensor from thermal radiation.
Monitoring frequency:	Continuously, aggregated in monthly average values
QA/QC procedures:	In case that project participants decide to measure temperature in the project site: • Uncertainty of the measurements provided by temperature sensor supplier should be discounted from the readings.
Any comment:	

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

Data / Parameter:	$HG_{PJ,y}$
Data unit:	GJ/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, NCV 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:	-

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Data / Parameter:	$F_{PJ,effl,dig,m}$ $F_{PJ,effl,lag,m}$
Data unit:	m^3/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*
Source of data:	Measured
Measurement procedures (if any):	-
Monitoring frequency:	Parameter monitored continuously but aggregated monthly for calculations
QA/QC procedures:	-
Any comment:	*m* = Months of year *y* of the crediting period

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Data / Parameter:	$S_{LA,m}$ $DWW_{LA,m}$
Data unit:	t/month
Description:	Amount of sludge applied to land in month *m* Amount of dewatered wastewater applied to land in month *m*
Source of data:	Measured
Measurement procedures (if any):	-
Monitoring frequency:	Parameter monitored continuously but aggregated monthly for calculations
QA/QC procedures:	-
Any comment:	-

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Data / Parameter:	$w_{sludge,COD,LA,m}$
Data unit:	t COD/t sludge
Description:	Chemical oxygen demand in the sludge applied to land after the dewatering process in month *m*
Source of data:	Measurements
Measurement procedures (if any):	Measure the COD according to national or international standards. If COD is measured more than once per month, the average value of the measurements should be used
Monitoring frequency:	Regularly, calculate average monthly and annual values
QA/QC procedures:	-
Any comment:	-

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Data / Parameter:	$w_{ww,COD,LA,m}$
Data unit:	t COD/t dewatered wastewater
Description:	Chemical oxygen demand in the dewatered wastewater in month *m*
Source of data:	Measurements
Measurement procedures (if any):	Measure the COD according to national or international standards. If COD is measured more than once per month, the average value of the measurements should be used

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Monitoring frequency:	Regularly, calculate average monthly and annual values
QA/QC procedures:	-
Any comment:	-

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

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

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Data / Parameter:	$SM_{PJ,k,y}$
Data unit:	tons of dry matter
Description:	Quantity of solid materials type *k* during the year *y*
Source of data:	On-site measurements
Measurement procedures (if any):	Use weight meters and adjust for the moisture content in order to determine the quantity of dry matter
Monitoring frequency:	Daily, calculate monthly and annual values
QA/QC procedures:	-
Any comment:	Applicable if leakage occurs due to displacement of animal fodder

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Data / Parameter:	$F_{biogas,y}$
Data unit:	m^3/yr
Description:	Total 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

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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 When biogas is generated from solid materials in a Scenario 1 project, this is to be separately monitored as $F_{biogas,SM,y}$ but included in the total amount of biogas monitored fur the purpose of determining physical leakage and flaring emissions

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Data / Parameter:	$w_{CH4,biogas,y}$
Data unit:	kg CH_4 / m^3
Description:	Concentration of methane in the total biogas supply 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:	-

554 ## APPENDIX 1: Illustration of the project activity and the baseline scenario

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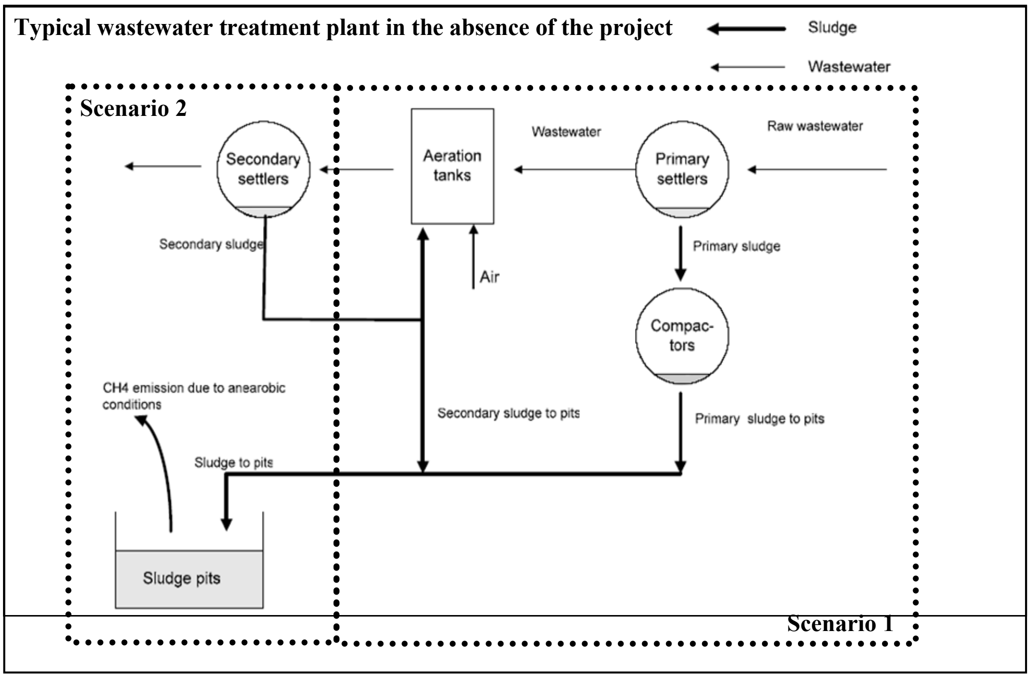

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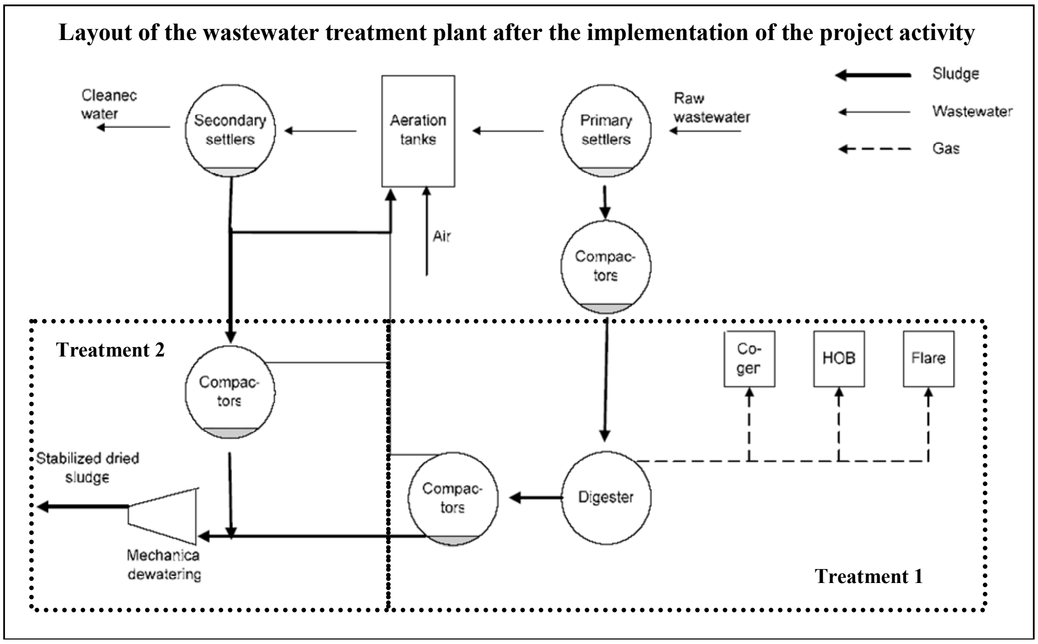

558 **History of the document**

Version	Date	Nature of revision(s)
05.0.0	EB 67, Annex # 11 May 2012	Revision to: • Broaden the applicability of the methodology to the treatment of any type of waste water; • Simplify the procedures to estimate baseline methane emissions and electricity generation; • Simplify the baseline determination for Greenfield project activities • Improve the overall structure of the methodology; • Introduce provisions for the use of this methodology in a project activity under a programme of activities (PoA); • Change the title from “Mitigation of greenhouse gas emissions from treatment of industrial wastewater” to “Treatment of wastewater”. Due to the overall modification of the documents, no highlights of the changes are provided.
04.1.0	EB 58, Annex 9 26 November 2010	Revision to expand the application of the methodology to include a situation in the project scenario where the wastewater is dewatered and directed to land application.
04	EB 55, Annex 13 30 July 2010	Revision to expand Scenario 1 for it to include a situation in the baseline where the solid materials are separated from the wastewater and have a different treatment than the wastewater.
03.1	EB 47, Annex 9 28 May 2009	Editorial corrections of parameters and units in equations 15, 16, 17 and 18.
03	EB 45, Annex 12 13 February 2009	• To delete the parameter $EF_{CH4,digest,y}$ from the monitoring table; • To provide default leak factor for $FL_{biogas,digest,y}$ of 0.05 m³ biogas leaked / m³ biogas produced and move it to the ‘data not monitored’ section.
02.1	EB 39, Paragraph 22 16 May 2008	“Tool to calculate baseline, project and/or leakage emissions from electricity consumption” replaces the withdrawn “Tool to calculate project emissions from electricity consumption”.
02	EB 38, Annex 5 14 March 2008	• To extend applicability to include project activities implementation in Greenfield facilities; • 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.
Decision Class: Regulatory **Document Type**: Standard **Business Function**: Methodology		

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