20. Water and Waste Management / Waste Water Treatment (Methane Recovery)

1. Typical Project Outline

- Methane recovery and application from existing waste water treatment systems.
- Methane recovery and application from new waste water treatment systems.

2. Applicability

(1) Methane recovery from waste water treatment systems.

(2) Application of the recovered methane for power or/and thermal generation.

3. Methodology of Emission Reduction Calculation

The emission reduction from the project activity is determined as the differences between the GHG emissions of baseline scenario (methane are emitted to atmosphere without recovery) and project scenario (recovery methane from the waste water treatment systems)[1].

Details of sources of each data in the following formulae are provided in "4. Data and Parameters for the Estimation".

$$ER_y = BE_y - PE_y$$

ER_y : Emission reduction through the projet in year y (t-CO_2e/y)

BE_y : GHG emission from the baseline scenario in year y (t-CO_2e/y)

PE_y : GHG emission from the project scenario in year y (t-CO_2e/y)

(1) Calculation of Baseline Emission

The baseline emissions cover emissions from the following sources

- CO_2 emissions from electricity and fossil fuels consumed in the baseline scenario
- Methane emitted to the atmosphere from waste water treatment sites in the baseline scenario
- CO_2 emissions from generation of electric power and/or thermal energy that will be replaced by electricity or thermal energy generated by the project.

$$BE_y = BE_{EC,y} + BE_{FC,y} + BE_{ww,y} + BE_{EN,y}$$

$BE_{EC,y}$: CO_2 emissions from electricity consumed by wastewater treatment in the baseline scenario in year y (t-CO_2e/y)

$BE_{FC,y}$: CO_2 emissions from fossil fuels consumed by wastewater treatment in the baseline scenario in year y (t-CO_2e/y)

$BE_{ww,y}$: Methane emission from wastewater treatment sites in year y (t-CO_2e/y)

$BE_{EN,y}$: CO_2 emissions from generation of electric power and/or thermal energy that will be replaced by electricity or thermal energy generated by the project in year (t-CO_2e/y)

Determination of $BE_{EC,y}$:

It is determined by multiplying fuel consumption with CO_2 emission factor.

$$BE_{EC,y} = EC_{BL,y} \times EF_{elec}$$

[1] The target year shall be a representative year under average operation or an annual average of multiple years.

$EC_{BL,y}$: Electricity consumption associated with wastewater treatment in the baseline scenario (MWh/y)

EF_{elec} : CO_2 emission factor of the electricity (t-CO_2/MWh)

Determination of $BE_{FC,y}$:

It is determined as follows.

$$BE_{FC,y} = \sum_i \left(FC_{BL,i,y} \times NCV_{fuel,i} \times EF_{fuel,i} \div 10^6 \right)$$

$FC_{BL,i,y}$: Amount of the fuel i consumed associated with wastewater treatment in the baseline scenario in year y (t/y)

$NCV_{fuel,i}$: Net calorific value of the fuel i (TJ/Gg = TJ/kt)

$EF_{fuel,i}$: CO_2 emission factor of the fuel i (kg-CO_2/TJ)

Determination of $BE_{ww,y}$:

It is determined multiplying the volume of wastewater treated in the system, the COD removed through the treatment process, CH_4 producing capacity, and global warming potential.

$$BE_{ww,y} = Q_{ww,BL,y} \times COD_{ww,BL,y} \times MCF_{ww,BL} \times BO_{o,ww} \times UF_{BL} \times GWP_{CH4}$$

$Q_{ww,BL,y}$: Volume of wastewater treated in wastewater treatment system in the baseline scenario in year y (m^3/y)

$COD_{ww,BL,y}$: Chemical oxygen demand removed by the wastewater treatment system in the baseline scenario （t-COD/m^3）

$MCF_{ww,BL}$: CH_4 correction factor for the wastewater treatment system in the baseline scenario

$BO_{o,ww}$: CH_4 producing capacity of the wastewater (t-CH_4/t-COD)

UF_{BL} : Model correction factor to account for model uncertainties for baseline scenario

GWP_{CH4} : Global Warming Potential of CH_4 （=25 t-CO_2/t-CH_4）

Determination of $BE_{EN,y}$:

It is determined by the quantity of electricity and thermal energy generated after by the project and corresponding CO_2 emission factors.

$$BE_{EN,y} = BE_{elec,y} + BE_{ther,y} = EG_{PJ,y} \times EF_{elec} + HG_{PJ,y}/\eta_{BL} \times EF_{fuel,k} \div 10^3$$

BE_{elec} : Baseline emissions to generate the same amount of electricity generated by project activity in year y (t-CO_2/y)

$BE_{heat,y}$: Baseline emissions to generated the same amount of thermal energy produced by the project activity (t-CO_2/y)

$EG_{PJ,y}$: Amount of electricity generated by the project in year y (MWh/y)

EF_{elec} : CO_2emission factor of the electricity (t-CO_2/MWh)

$HG_{PJ,y}$: Amount of thermal energy generated by the project in year y (TJ/y)

η_{BL} : Energy efficiency of the boiler/air heater used in the baseline scenario to generate the thermal energy. It will be “1” as a conservative value.

$EF_{fuel,k}$: CO_2emission factor of the fuel k used for the boiler in the baseline scenario (kg-CO_2/TJ)

(2) Calculation of Project Emission

The project emissions equals to emissions of methane leakages from the methane recovery system.

$PE_y = PE_{ww,y}$

PE_y : GHG emission from the project in year y (t-CO_2e/y)

$PE_{ww,y}$: Methane leakage from the methane recovery system (t-CO_2e/y)

Determination of $PE_{ww,y}$:

It is determined as follows.

$PE_{ww,y} = MG_{PJ,y} \times GWP_{CH4} \times EF_{CH4,def}$

$MG_{PJ,y}$: Amount of methane recovered in year y (t-CH_4/y)

GWP_{CH4} : Global Warming Potential of CH_4 (=25 t-CO_2/t-CH_4)

$EF_{CH4,def}$: Methane leakage factor of the methane recovery system (t-CH_4 leaked/t-CH_4 produced)

Determination of $MG_{PJ,y}$:

It is determined as follows.

$MG_{PJ,y} = Q_{ww,PJ,y} \times COD_{ww,PJ,y} \times MCF_{ww,PJ} \times BO_{o,ww} \times UF_{PJ}$

$Q_{ww,PJ,y}$: Volume of wastewater treated in the project in year y (m^3/y)

$COD_{ww,PJ,y}$: Chemical oxygen demand removed by the wastewater treatment system in the project (t-COD/m^3)

$MCF_{ww,PJ}$: CH_4 correction factor for the wastewater treatment system in the project

$BO_{o,ww}$: CH_4 producing capacity of the wastewater (t-CH_4/t-COD)

UF_{PJ} : Model correction factor to account for model uncertainties for project

4. Data and Parameters for the Estimation

Data	Description	Data Sources	
		For baseline emission calculation	For project emission calculation
$EC_{BL,y}$	Electricity consumption associated with wastewater treatment in the baseline scenario (MWh/y)	A historical average based on the monitored/recorded values	N/A
EF_{elec}	In the case of grid connection: CO_2 emission factor of the grid electricity (t-CO_2/MWh)	A default value (Table 3, "Energy Consumption", Appendix) If there is no default value applied or if there is another appropriate value, that value may be used.	N/A
	In the case of captive power generation or mini-grid: CO_2 emission factor of the diesel power generation (t-CO_2/MWh)	A default value (Table 4, Appendix) If there is no default value applied or if there is another appropriate value, that value may be used.	N/A
$FC_{BL,i,y}$	Amount of fuel i	A historical average based on the	N/A

	consumed associated with wastewater treatment in the baseline scenario (t/year)	monitored/recorded values	
$NCV_{fuel,i}$	Net calorific value of the fuel i (TJ/Gg = TJ/kt)	An IPCC default value (Table 1, Appendix) If there is no default value applied or if there is another appropriate value, that value may be used.	N/A
$EF_{fuel,i}$	CO_2 emission factor of the fuel i (kg-CO_2/TJ)	An IPCC default value (Table 2, Appendix) If there is no default value applied or if there is another appropriate value, that value may be used.	N/A
$EF_{fuel,k}$	CO_2 emission factor of fuel k used for the boiler in the baseline scenario (kg-CO_2/TJ)	An IPCC default value (Table 2, Appendix) If there is no default value applied or if there is another appropriate value, that value may be used.	N/A
$Q_{ww,BL,y}$	Volume of wastewater treated in wastewater treatment system in the baseline scenario in year y (m^3/y)	A monitored value	N/A
$Q_{ww,PJ,y}$	Volume of wastewater treated in the project in year y (m^3/y)	N/A	A planned value
$COD_{ww,BL,y}$	Chemical oxygen demand removed by the wastewater treatment system in the baseline scenario（t-COD/m^3）	A monitored value (Describe the measurement method (chrome method or manganese method) in the GHG emission reduction assessment report)	N/A
$COD_{ww,PJ,y}$	Chemical oxygen demand removed by the wastewater treatment system in the project（t-COD/m^3）	N/A	A planned value (Describe the measurement method (chrome method or manganese method) in the GHG emission reduction assessment report)
$MCF_{ww,BL}$	CH_4 correction factor for the wastewater treatment system in the baseline scenario	Default value of IPCC (Table 9, Appendix)	N/A
$MCF_{ww,PJ}$	CH_4 correction factor for the wastewater treatment system in the project	N/A	Default value of IPCC (Table 9, Appendix)
$BO_{o,ww}$	CH_4 producing capacity of the wastewater (t-CH_4/t-COD)	0.25 (Default value[2])	
UF_{BL}	Model correction factor to account for model uncertainties for baseline scenario	0.89 (Default value of CDM AMS III.H. ver.19.0)	N/A
UF_{PJ}	Model correction factor to account for model	N/A	1.12 (Default value of CDM AMS III.H.

[2] 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 5: Waste, p.6.18

	uncertainties for project		ver.19.0)
$EG_{PJ,y}$	Amount of electricity generated by the project in year y (MWh/y)	A planned value	N/A
$HG_{PJ,y}$	Amount of thermal energy generated by the project in year y (TJ/y)	A planned value	N/A
$EF_{CH4,def}$	Methane leakage factor of methane recovery system (tCH_4 leaked/tCH_4 produced)	N/A	0.1 (Default value: CDM Methodological Tool Project and leakage emissions from anaerobic digesters (Version 01.0.0))

5. Others

(1) Project Boundary

The project boundary is the site where the project activity is being done, where the wastes waters are treated.

(2) Leakage

Construction of power plants, replacement of facility: the indirect emissions potentially leading to leakage due to activities such as product manufacturing or materials transport in consideration of Life Cycle Assessment, LCA of disposal of waste at a solid waste disposal site. The contribution of this emission is relatively small and negligible compared with the GHG emission reduction after the project starts. Therefore, this methodology ignores the leakage provided that the technology is using equipment not transferred from another activity.

(3) Comparison with existing CDM methodologies

The logic of emission reduction calculation in the methodology is almost the same as that of the AMS-III.H (Methane recovery in wastewater treatment, Version 16). However, this methodology simplified the methodology by using default values as more as possible. For example, emissions from sludge that is not covered in the methane recovery system and waster water after treated are ignored due conservatives and simplicity. Moreover, there is no limitation for the emission reduction in the methodology like the small-scale CDM methodologies did.

Also, it is a project that collects methane generated in wastewater treatment facilities and uses it for power generation and heat supply, and there seems to be no significant difference between N_2O generated in the baseline and the project. Therefore, N_2O is ignored.

(4) Revision history

Version	Year/Month	Revisions
2.0	March 2014	• Changed the methodology name from “24. Waste water treatment (Ver 1.0)” to “Waste water treatment (methane recovery)” • Amended project emission calculation to calculate GHG emission from wastewater treated in the project (i.e. Methane leakage from the methane recovery system) only • Added default values for combined margins and operating margins of CO2 emission factors of electricity

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3.0	September 2019	• Prioritized the use of default values • Added instructions not to consider N_2O emissions
4.0	March 2023	• Deleted descriptions on treatment of sludge in the GHG emission calculation associated with electricity consumption under the baseline scenario. • Regarding the measurement of COD, added that the measurement method (chrome method or manganese method) should be specified in the GHG emission reduction calculation report, etc. • In the description of the calculation method and necessary data of baseline emissions, the words "before project implementation" was revised to use "the baseline scenario". The baseline scenario is the scenario that would have occurred in the absence of the project, such as continuation of the pre-project conditions. • Deleted the column "Ex-post" in "4. Data and Parameters Estimated and Need Monitoring": current version of Climate-FIT aims to quantify GHG emission reductions in the "planning phase").
5.0	March 2024	• Corrected the value of Model correction factor (UF) to default values of CDM methodology AMS III.H. • The source of the CH_4 producing capacity ($BO_{o,ww}$) was corrected to apply IPCC 2019. • Removed subscript y of each parameter, which implies monitoring for each year (since Climate-FIT is intended to quantify GHG emission reductions in the "planning phase").