21. Sewerage Sludge Management/Methane Recovery or Composting

1. Typical Project Outline

- Methane recovery and application from treatment of sludge or composting sludge of waste treatment systems.

2. Applicability

(1) In the absence of the project, methane is emitted from sludge.

(2) Sludge is composted and the compost is used in aerobic condition or the recovered methane are used 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 sludge treatment systems or composting the sludge).

$$ER_y = BE_y - PE_y$$

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

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

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

(1) Calculation of Baseline Emission

The baseline emissions cover emissions from the following sources.

- Methane emitted to the atmosphere from sludge treatment sites
- 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.

$$BE_y = BE_{sl,y} + BE_{EN,y}$$

$BE_{sl,y}$: Methane emission from sludge 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 y (t-CO_2e/y)

Determination of $BE_{sl,y}$:

It is determined by multiplying the volume of the sludge by CH_4 correction factor of the disposal site, degradable organic content of the untreated sludge, fraction of DOC dissimilated to biogas, model correction factor, fraction of CH_4 in biogas, and methane global warming potential.

$$BE_{sl,y} = S_{PJ,y} \times MCF_{sl,BL,y} \times DOC_s \times UF_{BL} \times DOC_f \times F \times 16/12 \times GWP_{CH4}$$

$S_{PJ,y}$: Amount of sludge treated in the project in year y (t/y)

$MCF_{sl,BL,y}$: CH_4 correction factor sludge treatment in the baseline scenario

DOC_s : Degradable organic content of the untreated sludge

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

DOC_f : Fraction of DOC dissimilated to biogas

F : Fraction of methane in the biogas

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.

$$BE_{EN,y} = BE_{elec,y} + BE_{ther,y} = EG_{PJ,y} \times EF_{elec} + HG_{PJ,y}/\eta_{BL} \times EF_{fuel,i}$$

$BE_{elec,y}$: 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 generate 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 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 absence of the project activity to generate the thermal energy

It will be "1" as a conservative value.

$EF_{fuel,i}$: CO_2emission factor of fuel used in the absence of the project (t-CO_2/TJ)

(2) Calculation of Project Emission

The project emissions cover the following sources.

- Methane leakage from methane recovery system
- Methane leakage from composting process
- CO_2 emissions from consumption of electric power and/or thermal energy by the project.

$$PE_y = PE_{sl,y} + PE_{co,y} + PE_{EN,y}$$

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

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

$PE_{co,y}$: Methane leakage from the composting system in year y (t-CO_2e/y)

$PE_{EN,y}$: CO_2 emissions from consumption of electricity and fossil fuels in year y (t-CO_2e/y)

Determination of $PE_{sl,y}$:

It is determined as follows.

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

$MG_{PJ,y}$: 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 methane recovery system (t-CH_4 leaked / t-CH_4 produced)

Determination of $MG_{PJ,y}$:

It is determined as follows.

$$MG_{PJ,y} = S_{PJ,y} \times MCF_{sl,PJ,y} \times DOC_s \times UF_{PJ} \times DOC_f \times F \times 16/12$$

$S_{PJ,y}$: Volume of sludge treated in in the project in year y (t/y)

COD_s : Degradable organic content of the untreated sludge

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

DOC_f : Fraction of DOC dissimilated to biogas

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

F : Methane content of the biogas

Determination of $PE_{co,y}$:

It is determined as follows.

$$PE_{co,y} = S_{PJ,y} \times (EF_{co,CH4,def} \times GWP_{CH4} + EF_{co,N2O,def} \times GWP_{N2O})$$

$S_{PJ,y}$: Volume of sludge treated in in the project in year y (t/y)

$EF_{co,CH4,def}$: Methane leakage factor of composting process (t-CH_4/t-sludge)

$EF_{co,N2O,def}$: Nitrous oxide leakage factor of composting process (t-N_2O/t-sludge)

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

GWP_{N2O} : Global Warming Potential of N_2O (=298 t-CO_2/t-N_2O)

Determination of $PE_{EN,y}$:

It is determined by multiplying amount of electricity and fossil fuels consumed by their corresponding emission factors.

$$PE_{EN,y} = (EC_{PJ,y} \times EF_{elec}) + \sum_i (FC_{PJ,i,y} \times NCV_{fuel,i} \times EF_{fuel,i})$$

$EC_{PJ,y}$: Electricity consumed by the project in year y (MWh/y)

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

$FC_{PJ,i,y}$: Fossil fuel i consumed by the project in year y (t/y)

$NCV_{fuel,i}$: Net calorific value of the fuel i used in the project (TJ/t)

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

4. Data and Parameters Estimated and Need Monitoring

Data	Description	Data Sources			
		For baseline emission calculation		For project emission calculation	
		Ex-ante	Ex-post	Ex-ante	Ex-post
$EC_{PJ,y}$	Electricity consumed by the project in year y	N/A	N/A	A monitored value	A monitored value

	(MWh/y)				
EF_{elec}	In the case of a grid CO_2 emission factor ($t\text{-}CO_2/MWh$)	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.			
	In the case of stand alone power generation or mini grid: CO_2 emission factor of diesel generator ($t\text{-}CO_2/MWh$)	A default value (Table 5, Appendix) If there is no default value applied or if there is another appropriate value, that value may be used.			
$FC_{PJ,i,y}$	Amount of fuel i consumed by the project (t/year)	N/A	N/A	A monitored value	A monitored value
$NCV_{fuel,i}$	Net calorific value of fuel i used (TJ/t)	N/A	N/A	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.	
$EF_{fuel,i}$	CO_2 emission factor of fuel i ($t\text{-}CO_2/TJ$)	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.			
$S_{PJ,y}$	Amount of sludge treated by the project in year y (t/y)	A planned value	A monitored value	A planned value	A monitored value
$MCF_{sl,BL,y}$	CH_4 correction factor for the sludge treatment system in the baseline scenario	Default value of IPCC (Table 10, Appendix)		N/A	
$MCF_{sl,PJ,y}$	CH_4 correction factor for the sludge treatment system in the project	N/A		Default value of IPCC (Table 10, Appendix)	
UF_{BL}	Model correction factor to account for model uncertainties for baseline	0.94 (Default value: FCCC/SBSTA/2003/10/Add.2)		N/A	N/A
UF_{PJ}	Model correction factor to account for model uncertainties for project	N/A	N/A	1.06 (Default value: FCCC/SBSTA/2003/10/Add.2)	
DOC_s	Degradable organic content of the untreated sludge	An IPCC default value（Table 12, Appendix） If there is no default value applied or if there is another appropriate value, that value may be used.			
DOC_f	Fraction of DOC dissimilated to biogas	0.5 (Default value: 2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 5 Waste)			
F	Methane content of biogas	0.5 (Default value: 2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 5 Waste)			
$EF_{co,CH4,def}$	Methane leakage factor of composting process（$t\text{-}CH_4/t\text{-}sludge$）	N/A	N/A	0.01 (Default value: 2006 IPCC Guidelines for National Greenhouse Gas Inventories)	
$EF_{co,N2O,def}$	Nitrous oxide leakage factor of composting process（$t\text{-}N_2O/t\text{-}sludge$）	N/A	N/A	0.0006 (Default value: 2006 IPCC Guidelines for National Greenhouse Gas Inventories)	
$EG_{PJ,y}$	Electricity generated by the project in year y（MWh/y）	A planned value	A monitored value	N/A	N/A
$HG_{PJ,y}$	Amount of thermal	A planned value	A monitored value	N/A	N/A

	energy generated by the project in year y (TJ/y)				
$EF_{CH4,def}$	Methane leakage factor of anaerobic treatment system (t-CH_4 leaked / t-CH_4 produced)	N/A		0.1 (Default value: Methodological Tool Project and leakage emissions from anaerobic digesters)	

5. Others

(1) Project Boundary

The project boundary is the site where the project activity is being done, where the sludge 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.F (Avoidance of methane emissions through composting, Version 11) and AMS-III.AO (Methane recovery through controlled anaerobic digestion, Version 01). However, this methodology simplified the methodology by using default values as more as possible. Moreover, there is no limitation for the emission reduction in the methodology like the small-scale CDM methodologies did.