

# **ANNEX 1**

---

# **WORKSHEETS**

## Contents

Annex 1	Worksheets	
4B	Biological Treatment of Solid Waste .....	A1.3
	CH <sub>4</sub> emissions from Biological Treatment of Solid Waste .....	A1.3
	N <sub>2</sub> O emissions from Biological Treatment of Solid Waste .....	A1.4
4C	Incineration and Open-Burning of Waste .....	A1.5
	CO <sub>2</sub> emissions from Incineration of Waste .....	A1.5
	Total amount of waste open-burned .....	A1.6
	CO <sub>2</sub> emissions from Open Burning of Waste .....	A1.7
	CO <sub>2</sub> emissions from incineration of fossil liquid waste .....	A1.8
	CH <sub>4</sub> emissions from Incineration of Waste .....	A1.9
	CH <sub>4</sub> emissions from Open Burning of Waste .....	A1.10
	N <sub>2</sub> O emissions from Incineration of Waste .....	A1.11
	N <sub>2</sub> O emissions from Open Burning of Waste .....	A1.12
4D	Wastewater Treatment and Discharge .....	A1.13
	Organically Degradable Material in Domestic Wastewater .....	A1.13
	CH <sub>4</sub> emission factor for Domestic Wastewater .....	A1.14
	CH <sub>4</sub> emissions from Domestic Wastewater .....	A1.15
	Total Organic Degradable Material in wastewater for each industry sector .....	A1.16
	CH <sub>4</sub> emission factor for Industrial Wastewater .....	A1.17
	CH <sub>4</sub> emissions from Industrial Wastewater .....	A1.18
	Estimation of nitrogen in effluent .....	A1.19
	Estimation of emission factor and emissions of indirect N <sub>2</sub> O from Wastewater .....	A1.20

Note: For 4A Category Solid Waste Disposal, see spreadsheet IPCC Waste Model.

<b>Sector</b>		<b>Waste</b>				
<b>Category</b>		<b>Biological Treatment of Solid Waste</b>				
<b>Category Code</b>		<b>4B</b>				
<b>Sheet</b>		<b>1 of 1 Estimation of CH<sub>4</sub> emissions from Biological Treatment of Solid Waste</b>				
		<b>STEP 1</b>		<b>STEP 2</b>		<b>STEP 3</b>
<b>Biological Treatment System</b>	<b>Waste Category/ Types of Waste<sup>1</sup></b>	<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>	<b>E</b>
		Total Annual amount treated by biological treatment facilities <sup>3</sup>	Emission Factor	Gross Annual Methane Generation	Recovered/flared Methane per Year	Net Annual Methane Emissions
		(Gg)	(g CH <sub>4</sub> /kg waste treated)	(Gg CH <sub>4</sub> )	(Gg CH <sub>4</sub> )	(Gg CH <sub>4</sub> )
				$C = (A \times B) \times 10^{-3}$		$E = (C - D)$
<b>Composting</b>						
<b>Anaerobic digestion at biogas facilities<sup>2</sup></b>						
<b>Total</b>						
<sup>1</sup> Information on the waste category should include information of the origin of the waste (MSW, Industrial, Sludge or Other) and type of waste (Food waste or Garden and Park Waste). <sup>2</sup> If anaerobic digestion involves recovery and energy use of the gas, the emissions should be reported in the Energy Sector. <sup>3</sup> Information on whether the amount treated is given as wet or dry weight should be given.						

<b>Sector</b>		<b>Waste</b>			
<b>Category</b>		<b>Biological Treatment of Solid Waste</b>			
<b>Category Code</b>		<b>4B</b>			
<b>Sheet</b>		<b>1 of 1 Estimation of N<sub>2</sub>O emissions from Biological Treatment of Solid Waste</b>			
		<b>STEP 1</b>		<b>STEP 2</b>	
<b>Biological Treatment System</b>	<b>Waste Category /Types of Waste<sup>1</sup></b>	<b>A</b>	<b>B</b>	<b>C</b>	
		Total Annual amount treated by biological treatment facilities <sup>3</sup> (Gg)	Emission Factor (g N <sub>2</sub> O/kg waste treated)	Net Annual Nitrous Oxide Emissions (Gg N <sub>2</sub> O)	
				$E = (C - D) \times 10^{-3}$	
<b>Composting</b>					
<b>Anaerobic digestion at biogas facilities<sup>2</sup></b>					
				<b>Total</b>	
<p>1 Information on the waste category should include information of the origin of the waste (MSW, Industrial, Sludge or Other) and type of waste (Food waste or Garden and Park Waste).</p> <p>2 If anaerobic digestion involves recovery and energy use of the gas, the emissions should be reported in the Energy Sector.</p> <p>3 Information on whether the amount treated is given as wet or dry weight should be given.</p>					

<b>Sector</b>	<b>Waste</b>						
<b>Category</b>	<b>Incineration and Open Burning of Waste</b>						
<b>Category Code</b>	<b>4C1</b>						
<b>Sheet</b>	<b>I of I Estimation of CO<sub>2</sub> emissions from Incineration of Waste</b>						
<b>Type of Waste</b>	<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>	<b>E</b>	<b>F</b>	<b>G</b>
	Total Amount of Waste Incinerated (Wet Weight)	Dry Matter Content <sup>1</sup>	Fraction of Carbon in Dry Matter <sup>2</sup>	Fraction of Fossil Carbon in Total Carbon <sup>3</sup>	Oxidation Factor	Conversion Factor	Fossil CO <sub>2</sub> Emissions
	(Gg Waste)	dm (fraction)	CF (fraction)	FCF (fraction)	OF (fraction)	44/12	(Gg CO <sub>2</sub> )
							G = A x B x C x D x E x F
Municipal Solid Waste (MSW) <sup>4, 5</sup>							
Composition <sup>4,5</sup>	Plastics						
	Textiles						
	Rubber						
	Nappies						
Industrial solid waste							
Hazardous waste							
Clinical waste							
Sewage sludge							
Other (specify)							
<b>Total</b>							
<p>1 For default data and relevant equations on the dry matter content in MSW and other types of waste, see Section 5.3.3 in Chapter 5.</p> <p>2 For default data and relevant equations on the fraction of carbon, see Section 5.4.1.1 in Chapter 5.</p> <p>3 For default data and relevant equations on the fraction of fossil carbon, see Section 5.4.1.2 in Chapter 5.</p> <p>4 Users may either enter all MSW incinerated in the MSW row or the amount of waste by composition by adding the appropriate rows.</p> <p>5 All relevant fractions of fossil C should be included. For consistency with the CH<sub>4</sub> and N<sub>2</sub>O sheets, the total amount incinerated should be reported here. However the fossil CO<sub>2</sub> emissions from MSW should be reported only once (either for total MSW or the components).</p>							

<b>Sector</b>	<b>Waste</b>					
<b>Category</b>	<b>Incineration and Open Burning of Waste</b>					
<b>Category Code</b>	<b>4C1</b>					
<b>Sheet</b>	<b>1 of 1 Estimation of total amount of waste open-burned</b>					
<b>STEP 1</b>						
<b>Region, city, etc.</b>	<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>	<b>E</b>	<b>F</b>
	Population	Fraction of Population Burning Waste	Per Capita Waste Generation	Fraction of the waste amount burned relative to the total amount of waste treated	Number of days by year 365	Total Amount of MSW Open-burned
	P (Capita)	P <sub>frac</sub> (fraction)	MSW <sub>P</sub> (kg waste/capita/day)	B <sub>frac</sub> <sup>1</sup> (fraction)	(day)	MSW <sub>B</sub> (Gg/yr)
						F = A x B x C x D x E
Sum of regions, cities, etc. (Total amount of MSW open-burned in the country)						
<b>Total</b>						
1 When all the amount of waste is burned B <sub>frac</sub> could be considered equal 1. When a substantial quantity of waste in open dumps is burned, a relatively large part of waste is left unburned. In this situation, B <sub>frac</sub> should be estimated using survey or research data available or expert judgement.						

<b>Sector</b>		<b>Waste</b>						
<b>Category</b>		<b>Incineration and Open Burning of Waste</b>						
<b>Category Code</b>		<b>4C2</b>						
<b>Sheet</b>		<b>1 of 1 Estimation of CO<sub>2</sub> emissions from Open Burning of Waste</b>						
<b>STEP 1</b>		<b>STEP 2</b>						
<b>Type of Waste</b>		<b>F</b>	<b>G</b>	<b>H</b>	<b>I</b>	<b>J</b>	<b>K</b>	<b>L</b>
		Total Amount of Waste open-burned (Wet Weight)	Dry Matter Content <sup>1</sup>	Fraction of Carbon in Dry Matter <sup>2</sup>	Fraction of Fossil Carbon in Total Carbon <sup>3</sup>	Oxidation Factor	Conversion Factor	Fossil CO <sub>2</sub> Emissions
		(Gg Waste)	dm (fraction)	CF (fraction)	FCF (fraction)	OF (fraction)	44/12	(Gg CO <sub>2</sub> )
		$F = (A \times B \times C \times D)^4$						$L = F \times G \times H \times I \times J \times K$
Municipal Solid Waste (MSW) <sup>5,6</sup>		This comes from previous table						
Composition <sup>5,6</sup>	Plastics							
	Textiles							
	Rubber							
	Nappies							
	etc							
	add as needed							
Other (specify)								
<b>Total</b>								
<p>1 For default data and relevant equations on the dry matter content in MSW and other types of waste, see Section 5.3.3 in Chapter 5.</p> <p>2 For default data and relevant equations on the fraction of carbon, see Section 5.4.1.1 in Chapter 5.</p> <p>3 For default data and relevant equations on the fraction of fossil carbon, see Section 5.4.1.2 in Chapter 5.</p> <p>4 The amount MSW can be calculated in the previous sheet "Estimation of Total Amount of Waste Open-burned". See also Equation 5.7.</p> <p>5 Users may either enter all MSW incinerated in the MSW row or the amount of waste by composition by adding the appropriate rows.</p> <p>6 All relevant fractions of fossil C should be included. For consistency with the CH<sub>4</sub> and N<sub>2</sub>O sheets, the total amount open-burned should be reported here. However, the fossil CO<sub>2</sub> emissions from MSW should be reported only once (either for total MSW or the components).</p>								

<b>Sector</b>	<b>Waste</b>				
<b>Category</b>	<b>Incineration and Open Burning of Waste</b>				
<b>Category Code</b>	<b>4C1</b>				
<b>Sheet</b>	<b>I of I Estimation of CO<sub>2</sub> emissions from incineration of fossil liquid waste</b>				
Type of Waste	A	B	C	D	E
	Total Amount of Fossil Liquid Waste Incinerated (Weight)	Fossil Carbon Content of Fossil Liquid Waste	Oxidation Factor for Fossil Liquid Waste of type i	Conversion Factor	Fossil CO <sub>2</sub> Emissions
	Gg Waste	CL (fraction)	OF (fraction)	44/12	(Gg CO <sub>2</sub> )
					E= A x B x C x D
Lubricants					
Solvents					
Waste oil					
Other (specify)					
<b>Total</b>					



<b>Sector</b>	<b>Waste</b>		
<b>Category</b>	<b>Incineration and Open Burning of Waste</b>		
<b>Category Code</b>	<b>4C1</b>		
<b>Sheet</b>	<b>I of I Estimation of CH<sub>4</sub> emissions from Incineration of Waste</b>		
<b>Type of Waste</b>	<b>A</b>	<b>B</b>	<b>C</b>
	Amount of Waste Incinerated (Wet Weight) <sup>1</sup> (Gg Waste)	Methane Emission Factor (kg CH <sub>4</sub> /Gg Wet Waste) <sup>1</sup>	Methane Emissions (Gg CH <sub>4</sub> )
			$C = A \times B \times 10^{-6}$ <sup>2</sup>
Municipal Solid Waste			
Industrial solid waste			
Hazardous waste			
Clinical waste			
Sewage sludge			
Other (specify)			
<b>Total</b>			
<sup>1</sup> If the total amount of waste is expressed in terms of dry waste, the CH <sub>4</sub> emission factor needs to refer to dry weight instead. <sup>2</sup> Factor of 10 <sup>-6</sup> as emission factor is given in kg /Gg waste incinerated on a wet weight basis.			

<b>Sector</b>	<b>Waste</b>		
<b>Category</b>	<b>Incineration and Open Burning of Waste</b>		
<b>Category Code</b>	<b>4C2</b>		
<b>Sheet</b>	<b>I of I Estimation of CH<sub>4</sub> emissions from Open Burning of Waste</b>		
<b>Type of Waste</b>	<b>F</b>	<b>G</b>	<b>H</b>
	Total Amount of Waste Open-burned (Wet Weight) <sup>1,2</sup> (Gg Waste)	Methane Emission Factor  (kg CH <sub>4</sub> /Gg Wet Waste) <sup>2</sup>	Methane Emissions  (Gg CH <sub>4</sub> )
			H= F x G x 10 <sup>-6</sup> <sup>3</sup>
Municipal Solid Waste			
Other (specify)			
<b>Total</b>			
<p>1 Total amount of MSW open-burned is obtained by estimates in the Worksheet "Total amount of waste open-burned".</p> <p>2 If the total amount of waste is expressed in term of dry waste, the CH<sub>4</sub> emission factor needs to refer to dry weight instead.</p> <p>3 Factor of 10<sup>-6</sup> as emission factor is given in kg /Gg waste incinerated on a wet weight basis.</p>			

<b>Sector</b>	<b>Waste</b>		
<b>Category</b>	<b>Incineration and Open Burning of Waste</b>		
<b>Category Code</b>	<b>4C1</b>		
<b>Sheet</b>	<b>I of I Estimation of N<sub>2</sub>O emissions from Incineration of Waste</b>		
<b>Type of Waste</b>	<b>A</b>	<b>B</b>	<b>C</b>
	Total Amount of Waste Incinerated (Wet Weight <sup>1</sup> ) (Gg Waste)	Nitrous Oxide Emission Factor (kg N <sub>2</sub> O/Gg Wet Waste) <sup>1</sup>	Nitrous Oxide Emissions (Gg N <sub>2</sub> O)
			$C = A \times B \times 10^{-6}$ <sup>2</sup>
Municipal Solid Waste			
Industrial solid waste			
Hazardous waste			
Clinical waste			
Sewage sludge			
Other (specify)			
<b>Total</b>			
<sup>1</sup> If the total amount of waste is expressed in terms of dry waste, the CH <sub>4</sub> emission factor needs to refer to dry weight instead. <sup>2</sup> Factor of 10 <sup>-6</sup> as emission factor is given in kg /Gg waste incinerated on a wet weight basis.			

<b>Sector</b>	<b>Waste</b>		
<b>Category</b>	<b>Incineration and Open Burning of Waste</b>		
<b>Category Code</b>	<b>4C2</b>		
<b>Sheet</b>	<b>I of I Estimation of N<sub>2</sub>O emissions from Open Burning of Waste</b>		
<b>Type of Waste</b>	<b>F</b>	<b>G</b>	<b>H</b>
	Total Amount of Waste Open-burned (Wet Weight) <sup>1,2</sup> (Gg Waste)	Nitrous Oxide Emission Factor  (kg N <sub>2</sub> O/Gg Dry Waste) <sup>2</sup>	Nitrous Oxide Emissions  (Gg N <sub>2</sub> O)
			$H = F \times G \times 10^{-6}$ <sup>3</sup>
Municipal Solid Waste			
Other (specify)			
<b>Total</b>			
<p>1 Total amount of MSW open-burned is obtained by estimates in the Worksheet "Total amount of waste open-burned".</p> <p>2 If the total amount of waste is expressed in terms of dry waste, a fraction of dry matter should not be applied.</p> <p>3 Factor of 10<sup>-6</sup> as emission factor is given in kg /Gg waste incinerated on a wet weight basis.</p>			

<b>Sector</b>	<b>Waste</b>			
<b>Category</b>	<b>Domestic Wastewater Treatment and Discharge</b>			
<b>Category Code</b>	<b>4D1</b>			
<b>Sheet</b>	<b>1 of 3 Estimation of Organically Degradable Material in Domestic Wastewater</b>			
<b>STEP 1</b>				
<b>Region or City</b>	<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>
	Population (P) cap	Degradable organic component (BOD) (kg BOD/cap.yr) <sup>1</sup>	Correction factor for industrial BOD discharged in sewers (I) <sup>2</sup>	Organically degradable material in wastewater (TOW) (kg BOD/yr)
				D = A x B x C
<b>Total</b>				
<sup>1</sup> g BOD/cap.day x 0.001 x 365 = kg BOD/cap.yr <sup>2</sup> Correction factor for additional industrial BOD discharged into sewers, (for collected the default is 1.25, for uncollected the default is 1.00).				

Sector	Waste		
Category	Domestic Wastewater Treatment and Discharge		
Category Code	4D1		
Sheet	2 of 3 Estimation of CH <sub>4</sub> emission factor for Domestic Wastewater		
STEP 2			
Type of treatment or discharge	A	B	C
	Maximum methane producing capacity (B <sub>0</sub> ) (kg CH <sub>4</sub> /kgBOD)	Methane correction factor for each treatment system (MCF <sub>j</sub> )	Emission factor (EF <sub>j</sub> ) (kg CH <sub>4</sub> /kg BOD)
			C = A x B
add as needed			

<b>Sector</b>	<b>Waste</b>							
<b>Category</b>	<b>Domestic Wastewater Treatment and Discharge</b>							
<b>Category Code</b>	<b>4D1</b>							
<b>Sheet</b>	<b>3 of 3 Estimation of CH<sub>4</sub> emissions from Domestic Wastewater</b>							
<b>STEP 3</b>								
Income group	Type of treatment or discharge pathway	A	B	C	D	E	F	G
		Fraction of population income group (U <sub>i</sub> ) (fraction)	Degree of utilization (T <sub>ij</sub> ) (fraction)	Emission Factor (EF <sub>j</sub> ) (kg CH <sub>4</sub> /kg BOD)	Organically degradable material in wastewater (TOW) (kg BOD/yr)	Sludge removed (S) (kg BOD/yr)	Methane recovered and flared (R) (kg CH <sub>4</sub> /yr)	Net methane emissions (CH <sub>4</sub> ) (kg CH <sub>4</sub> /yr)
				Sheet 2 of 3	Sheet 1 of 3			$G = [(A \times B \times C) \times (D - E)] - F$
Rural								
Urban high income								
Urban low income								
<b>Total</b>								

Sector	Waste			
Category	Industrial Wastewater Treatment and Discharge			
Category Code	4D2			
Sheet	1 of 3 Total Organic Degradable Material in wastewater for each industry sector			
STEP 1				
Industry Sectors	A	B	C	D
	Total industry product  (P <sub>i</sub> ) (t <sub>product</sub> /yr)	Wastewater generated (W <sub>i</sub> ) (m <sup>3</sup> /t <sub>product</sub> )	Chemical Oxygen Demand (COD <sub>i</sub> ) (kgCOD/m <sup>3</sup> )	Total organic degradable material in wastewater for each industry sector (TOW <sub>i</sub> ) (kgCOD/yr)
				D = A x B x C
Industrial sector 1				
Industrial sector 2				
Industrial sector 3				
add as needed				
Total				



<b>Sector</b>	<b>Waste</b>		
<b>Category</b>	<b>Industrial Wastewater Treatment and Discharge</b>		
<b>Category Code</b>	<b>4D2</b>		
<b>Sheet</b>	<b>2 of 3 Estimation of CH<sub>4</sub> emission factor for Industrial Wastewater</b>		
<b>STEP 2</b>			
Type of treatment or discharge	<b>A</b>	<b>B</b>	<b>C</b>
	Maximum Methane Producing Capacity (B <sub>0</sub> ) (kg CH <sub>4</sub> /kg COD)	Methane Correction Factor for the Treatment System (MCF <sub>j</sub> ) ( - )	Emission Factor (EF <sub>j</sub> ) (kg CH <sub>4</sub> /kg BOD)
			C = A x B
add as needed			

Sector	Waste					
Category	Industrial Wastewater Treatment and Discharge					
Category Code	4D2					
Sheet	3 of 3 Estimation of CH <sub>4</sub> emissions from Industrial Wastewater					
STEP 3						
Industrial sector		A	B	C	D	E
	Type of treatment or discharge pathway	Total organic degradable material in wastewater for each industry sector (TOW <sub>i</sub> )	Sludge removed in each industry sector (S <sub>i</sub> )	Emission factor for each treatment system (EF <sub>i</sub> )	Recovered CH <sub>4</sub> in each industry sector (R <sub>i</sub> )	Net methane emissions (CH <sub>4</sub> )
Units		(kg COD/yr)	(kg COD/yr)	(kg CH <sub>4</sub> /kgBOD)	(kg CH <sub>4</sub> /yr)	(kg CH <sub>4</sub> /yr)
		Sheet 1 of 3		Sheet 2 of 3		E = [(A – B) x C] – D
Industrial sector 1						
Industrial sector 2						
Industrial sector 3						
add as needed						
Total						

<b>Sector</b>	<b>Waste</b>						
<b>Category</b>	<b>Domestic Wastewater Treatment and Discharge</b>						
<b>Category Code</b>	<b>4D1</b>						
<b>Sheet</b>	<b>1 of 2 Estimation of nitrogen in effluent</b>						
	A	B	C	D	E	F	H
	Population	Per capita protein consumption	Fraction of nitrogen in protein	Fraction of non-consumption protein	Fraction of industrial and commercial co-discharged protein	Nitrogen removed with sludge (default is zero)	Total nitrogen in effluent
	(P)	(Protein)	(F <sub>NPR</sub> )	(F <sub>NON-CON</sub> )	(F <sub>IND-COM</sub> )	(N <sub>SLUDGE</sub> )	(N <sub>EFFLUENT</sub> )
units	(people)	(kg/person/year)	(kg N/kg protein)	(-)	(-)	(kg)	kg N/year)
							$H = (A \times B \times C \times D \times E) - F$
<b>Total</b>							

<b>Sector</b>	<b>Waste</b>				
<b>Category</b>	<b>Domestic Wastewater Treatment and Discharge</b>				
<b>Category Code</b>	<b>4D1</b>				
<b>Sheet</b>	<b>2 of 2 Estimation of emission factor and emissions of indirect N<sub>2</sub>O from Wastewater</b>				
	<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>	<b>E</b>
	Nitrogen in effluent (N <sub>EFFLUENT</sub> )	Emission factor	Conversion factor of kg N <sub>2</sub> O-N into kg N <sub>2</sub> O	Emissions from Wastewater plants (default = zero)	Total N <sub>2</sub> O emissions
	(kg N/year)	(kg N <sub>2</sub> O-N/kg N)	44/28	(kg N <sub>2</sub> O-N/year)	(kg N <sub>2</sub> O-N/year)
					E= A x B x C – D