IPCC Guideline Vol. 5 (Waste)

Greenhouse Gas Inventory System Training Workshop

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Incheon - ROK

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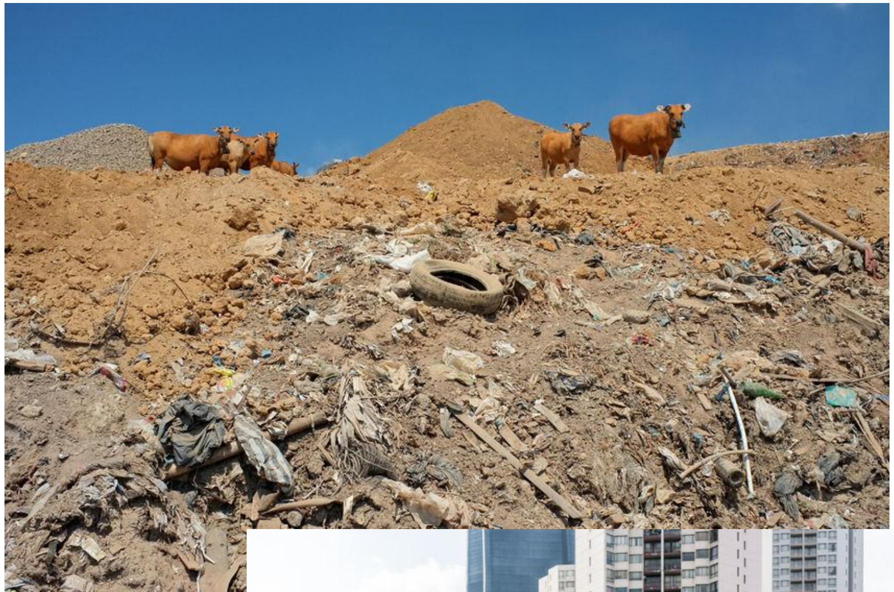
TGO

Training objective

"To reduce GHG emissions by establishing a transparent and reliable GHG inventory system to monitor and verify the current state of emissions. The GHG inventory system provides a basic approach in organizing monitoring, reporting, and verifying (MRV) procedures in each country."



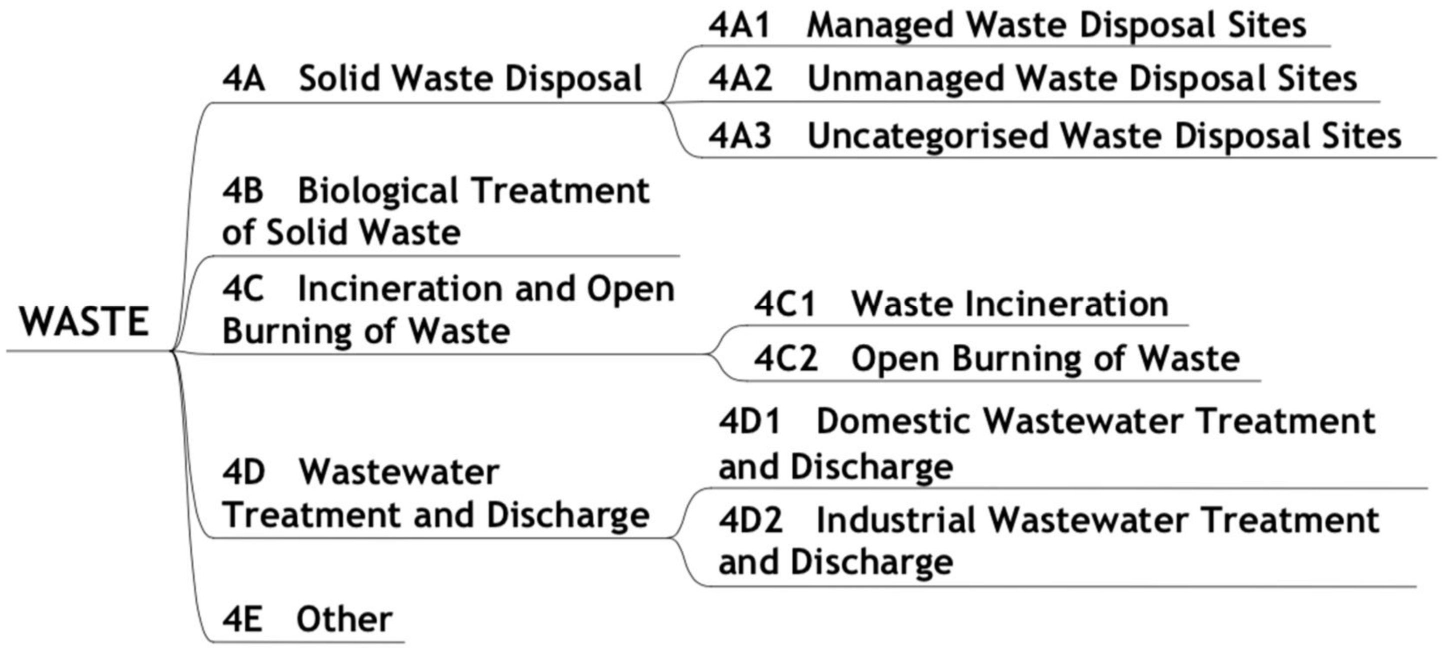
Presentation preview

1. IPPC Solid Waste emissions guidelines and estimation
2. IPPC Waste model and sample outputs
3. Biological treatment, burning of waste, wastewater guidelines
4. Projections and linkages to NDCs
5. MRV for the waste sector
6. Tools and resources
7. Conclusions

2006 IPCC Guidelines for National Greenhouse Gas Inventories (Waste)

- Waste Generation, Composition and Management Data
- Solid Waste Disposal
- Biological Treatment of Solid Waste
- Incineration and Open Burning of Waste
- Wastewater Treatment and Discharge

Waste Sector Overview



Estimates emissions of:

- Carbon dioxide (CO2)
- Methane (CH4)
- Nitrous Oxide (N2O)

Global warming potential:

- CO2 = 1 (reference)
- CH4 = 34
- N2O = 298

CH_4 emissions from solid waste disposal sites (SWDS) are typically the largest source in the Waste sector.

Municipal Solid Waste

- Household waste
- Garden (yard) and park waste
- Commercial/ institutional waste

TABLE 2.1
MSW GENERATION AND TREATMENT DATA - REGIONAL DEFAULTS

Region	MSW Generation Rate[1, 2, 3] (tonnes/cap/yr)	Fraction of MSW disposed to SWDS	Fraction of MSW incinerated	Fraction of MSW composted	Fraction of other MSW management, unspecified[4]
Asia					
Eastern Asia	0.37	0.55	0.26	0.01	0.18
South-Central Asia	0.21	0.74	-	0.05	0.21
South-East Asia	0.27	0.59	0.09	0.05	0.27

First Order Decay (FOD)

EQUATION 3.1
CH_4 EMISSION FROM SWDS

$$CH_4\ Emissions = \left[\sum_x CH_4\ generated_{x,T} - R_T \right] \bullet (1 - OX_T)$$

Where:

CH_4 Emissions = CH_4 emitted in year T, Gg

T = inventory year

x = waste category or type/material

R_T = recovered CH_4 in year T, Gg

OX_T = oxidation factor in year T, (fraction)

CH4 generated is estimated on the basis of the amount of **Decomposable Degradable Organic Carbon (DDOCm)** which is the part of the organic carbon that will degrade under the anaerobic conditions in SWDS.

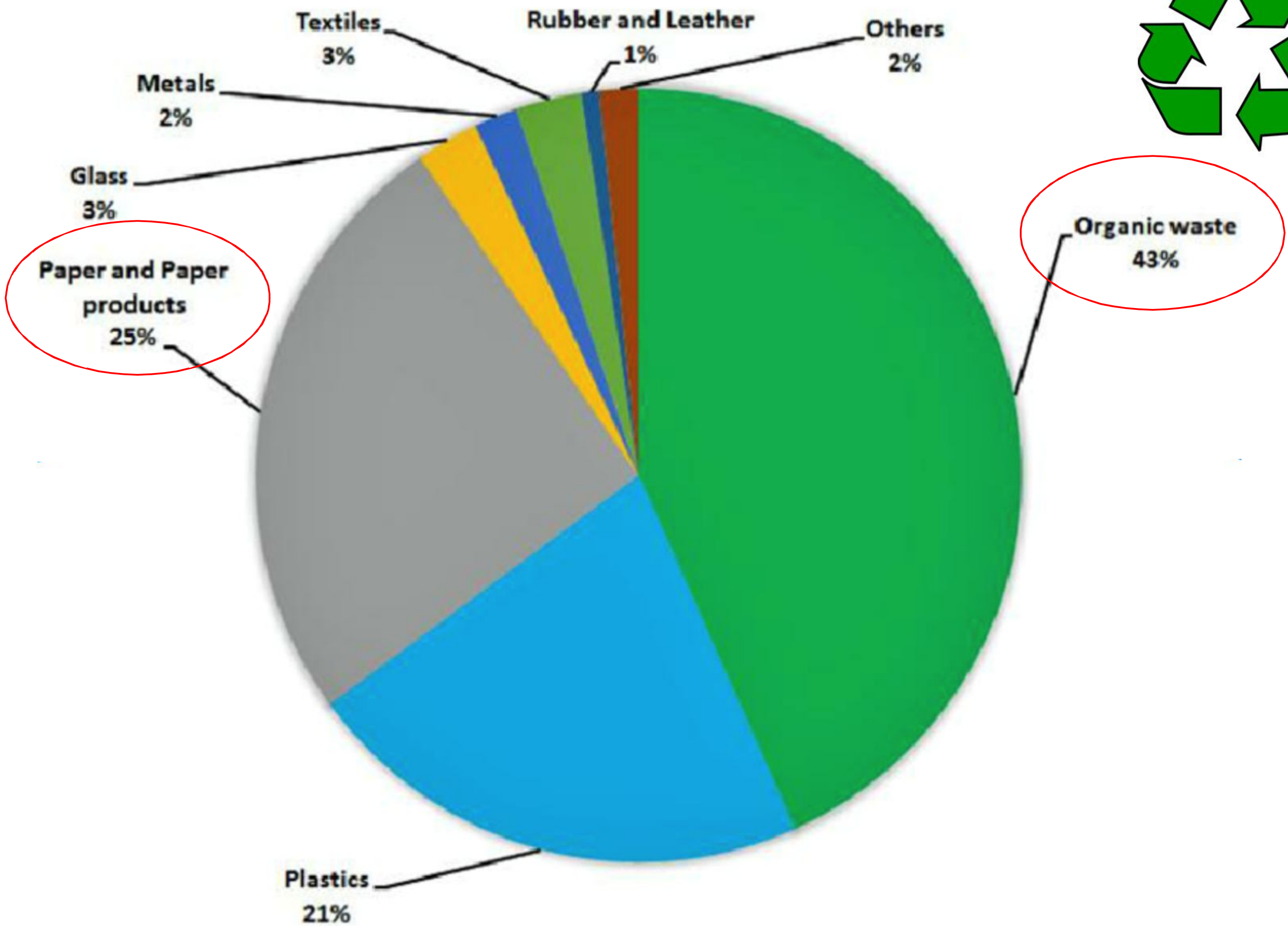
Waste composition

Default data provided for :

1. food waste
2. garden (yard) and park waste
3. paper and cardboard
4. wood
5. textiles
6. nappies (disposable diapers)
7. rubber and leather
8. plastics
9. metal
10. glass (and pottery and china)
11. other (e.g., ash, dirt, dust, soil, electronic waste)

MSW characteristics of waste generated in 2012

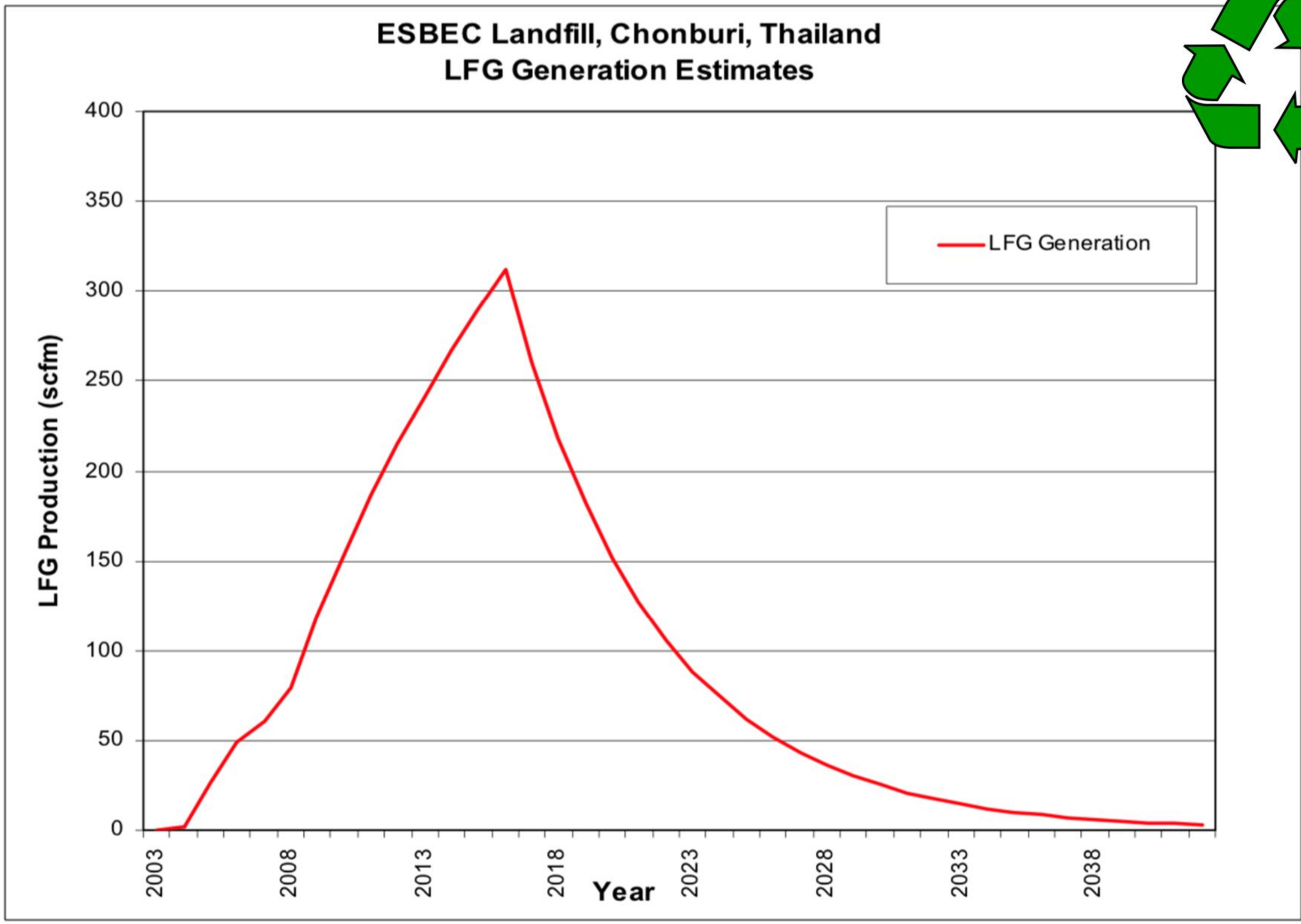
Kathmandu, Nepal



Source: ADB 2013

ESBEC Solid Waste Disposal Site

Chonburi, Thailand



Source: Global Methane Initiative, EPA LandGem

IPCC 2006 Waste Model

- ✓ Directed to countries with limited data on waste disposal
- ✓ Estimates GHG emissions over a time-series, using the first-order decay model
- ✓ Facilitates comparison of estimates between countries
- ✓ Permits assessment of impacts of different waste management and emission mitigation practices

IPPC Waste Model: Parameters - waste input

Parameters

Country **Thailand**

Region Asia- Southeast

Please enter parameters in the yellow cells. If no national data are available, copy the IPCC default value.
Help on parameter selection can be found in the 2006 IPCC guidelines

	IPCC default value		Country-specific parameters	
			Value	Reference and remarks
Starting year		1950	1950	
DOC (Degradable organic carbon)	Waste by comp			
(weight fraction, wet basis)	Waste by composi			
Food waste	Bulk waste data o		0.15	
Garden	0.18-0.22	0.2	0.2	
Paper	0.36-0.45	0.4	0.4	
Wood and straw	0.39-0.46	0.43	0.43	
Textiles	0.20-0.40	0.24	0.24	
Disposable nappies	0.18-0.32	0.24	0.24	
Sewage sludge	0.04-0.05	0.05	0.05	
Industrial waste	0-0.54	0.15	0.15	
DOCf (fraction of DOC dissimilated)		0.5	0.5	

Asia- Southeast
Asia: Eastern
Asia: South-central
Asia- Southeast
Asia- Western & Middle East

IPPC Waste Model: Parameters – climate selection

Methane generation rate constant (k) (years^{-1})	Wet temperate			
Food waste			0.185	
Garden			0.1	
Paper			0.06	
Wood and straw			0.03	
Textiles	0.05–0.07	0.06	0.06	
Disposable nappies	0.06–0.1	0.1	0.1	
Sewage sludge	0.1–0.2	0.185	0.185	
Industrial waste	0.08–0.1	0.09	0.09	

Dry temperate
Wet temperate
Dry tropical
Moist and wet tro

IPPC Waste Model:

MSW activity data

MSW activity data

Enter population, waste per capita and MSW waste composition into the yellow cells.
Help and default regional values are given in the 2006 IPCC Guidelines.
Industrial waste activity data must be entered separately starting in Column Q.

IPCC Regional defaults

Year	Population	Waste per capita	Total MSW	% to SWDS	Food	Garden	Paper	Wood	Textile	Nappies	Plastics, other inert	Total
	millions	kg/cap/yr	Gg	%	%	%	%	%	%	%	%	(=100%)
IPCC Regional defaults		270		59%	44%	0%	13%	10%	3%	0%	31%	100%
					Composition of waste going to solid waste disposal sites							
1950	10	270	2700	59%	44%	0%	13%	10%	3%	0%	31%	100%
1951	10	270	2700	59%	44%	0%	13%	10%	3%	0%	31%	100%
1952	10	270	2700	59%	44%	0%	13%	10%	3%	0%	31%	100%
1953	10	270	2700	59%	44%	0%	13%	10%	3%	0%	31%	100%
1954	10	270	2700	59%	44%	0%	13%	10%	3%	0%	31%	100%
1955	10	270	2700	59%	44%	0%	13%	10%	3%	0%	31%	100%
1956	10	270	2700	59%	44%	0%	13%	10%	3%	0%	31%	100%
1957	10	270	2700	59%	44%	0%	13%	10%	3%	0%	31%	100%
1958	10	270	2700	59%	44%	0%	13%	10%	3%	0%	31%	100%
1959	10	270	2700	59%	44%	0%	13%	10%	3%	0%	31%	100%
1960	10	270	2700	59%	44%	0%	13%	10%	3%	0%	31%	100%
1961	10	270	2700	59%	44%	0%	13%	10%	3%	0%	31%	100%
1962	10	270	2700	59%	44%	0%	13%	10%	3%	0%	31%	100%
1963	10	270	2700	59%	44%	0%	13%	10%	3%	0%	31%	100%
1964	10	270	2700	59%	44%	0%	13%	10%	3%	0%	31%	100%
1965	10	270	2700	59%	44%	0%	13%	10%	3%	0%	31%	100%
1966	10	270	2700	59%	44%	0%	13%	10%	3%	0%	31%	100%
1967	10	270	2700	59%	44%	0%	13%	10%	3%	0%	31%	100%
1968	10	270	2700	59%	44%	0%	13%	10%	3%	0%	31%	100%
1969	10	270	2700	59%	44%	0%	13%	10%	3%	0%	31%	100%
1970	10	270	2700	59%	44%	0%	13%	10%	3%	0%	31%	100%
1971	10	270	2700	59%	44%	0%	13%	10%	3%	0%	31%	100%
1972	10	270	2700	59%	44%	0%	13%	10%	3%	0%	31%	100%
1973	10	270	2700	59%	44%	0%	13%	10%	3%	0%	31%	100%
1974	10	270	2700	59%	44%	0%	13%	10%	3%	0%	31%	100%
1975	10	270	2700	59%	44%	0%	13%	10%	3%	0%	31%	100%
1976	10	270	2700	59%	44%	0%	13%	10%	3%	0%	31%	100%

IPPC Waste Model:

Results

Results

Country

Thailand

Enter starting year, industrial waste disposal data and methane recovery into the yellow cells.
MSW activity data is entered on MSW sheet

Year	Methane generated											Methane emission
	Food	Garden	Paper	Wood	Textile	Nappies	Sludge	MSW	Industrial	Total	Methane recovery	
	A	B	C	D	E	F	G	H	J	K	L	M = (K-L)*(1-OX)
	Gg	Gg	Gg	Gg	Gg	Gg	Gg	Gg	Gg	Gg	Gg	Gg
1950	0	0	0	0	0	0	0		0	0	0	0
1951	4	0	1	0	0	0	0		2	7	0	7
1952	8	0	2	1	0	0	0		3	14	0	14
1953	10	0	3	1	0	0	0		4	20	0	20
1954	13	0	4	2	1	0	0		5	25	0	25
1955	15	0	5	2	1	0	0		6	29	0	29
1956	16	0	6	3	1	0	0		7	33	0	33
1957	18	0	7	3	1	0	0		8	37	0	37
1958	19	0	7	3	1	0	0		9	40	0	40
1959	20	0	8	4	1	0	0		10	43	0	43
1960	21	0	9	4	1	0	0		11	45	0	45
1961	21	0	9	4	1	0	0		11	47	0	47
1962	22	0	10	5	1	0	0		12	50	0	50
1963	22	0	10	5	1	0	0		12	51	0	51
1964	23	0	11	5	1	0	0		13	53	0	53
1965	23	0	11	6	1	0	0		13	55	0	55
1966	23	0	12	6	1	0	0		14	56	0	56
1967	23	0	12	6	2	0	0		14	58	0	58
1968	24	0	13	7	2	0	0		14	59	0	59
1969	24	0	13	7	2	0	0		15	60	0	60
1970	24	0	13	7	2	0	0		15	61	0	61
1971	24	0	14	7	2	0	0		15	62	0	62
1972	24	0	14	8	2	0	0		15	63	0	63
1973	24	0	14	8	2	0	0		16	64	0	64
1974	24	0	15	8	2	0	0		16	65	0	65
1975	24	0	15	8	2	0	0		16	65	0	65

Summary: Default values

- ✓Climate
- ✓MSW composition
- ✓MSW generation
- ✓MSW management

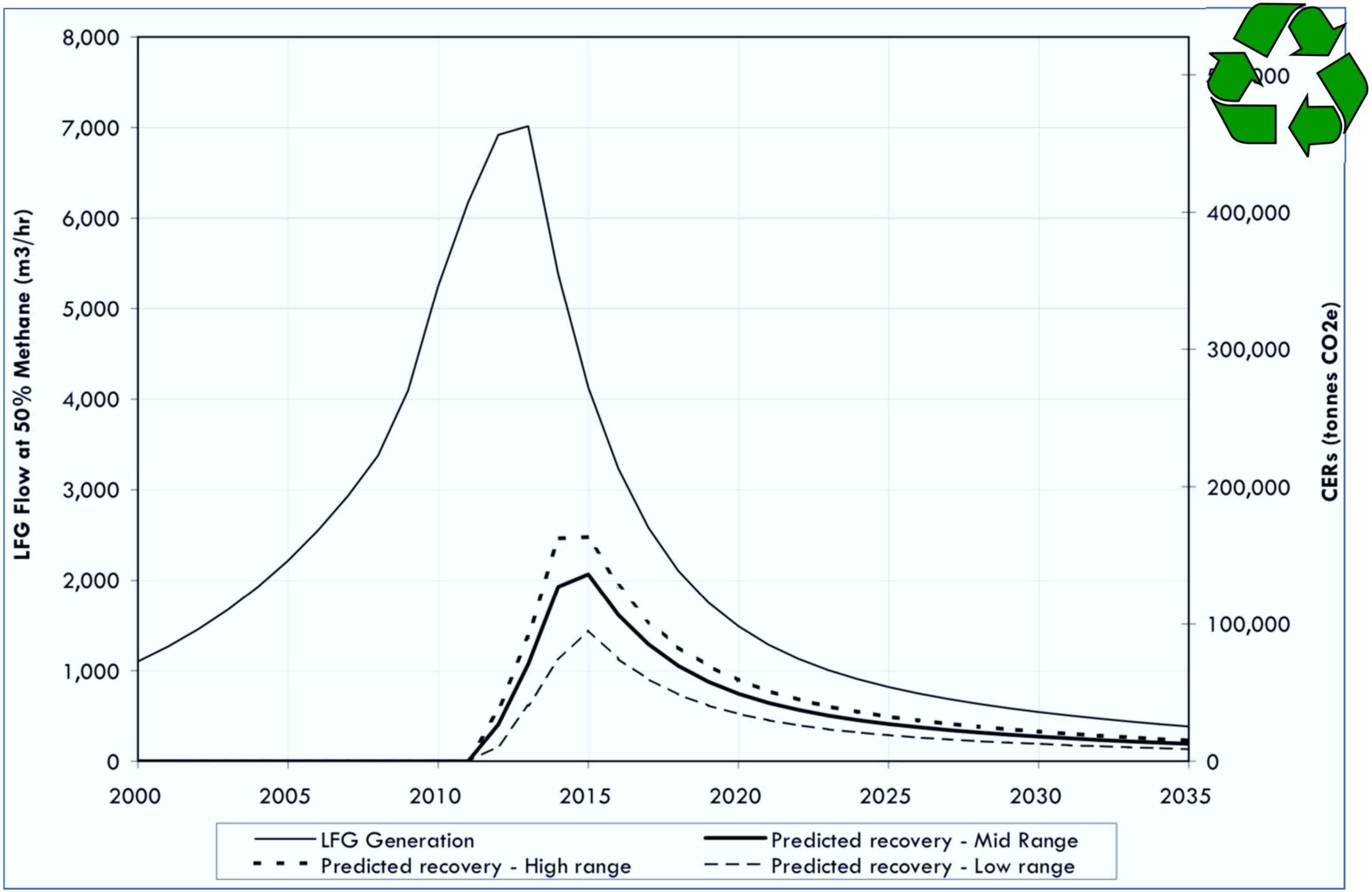
Other important default values

- **Degradable Organic Carbon (DOC)** – carbon that is accessible to decomposition (Gg C / Gg waste)
- **Fraction of DOC that Decomposes (DOC_f)** – estimate of fraction of carbon degraded and release from site
- **Methane Correction Factor (MCF)** - assigned based on the estimated fraction of waste which decays aerobically and does not produce methane
- **CH4 content in Landfill Gas** – typically 50% CH_4 / 50% CO_2
- **Oxidation Factor (OX)** - reflects amount of CH_4 from site that is converted to oxygen by the soil covering the waste
- **Half-life ($t_{1/2}$)** – time taken for DOC in waste to decay to half its initial mass

CH4 Generation and Recovery

Dhapa SWDS

Kolkatta, India



Source: Global Methane Initiative

Other possible GHG sources from solid waste

- Combustion of fossil-derived carbon in incineration systems resulting in the release of CO_2
- Production of CH_4 from anaerobic conditions within composting operations
- Release of nitrous oxide (N_2O) during nitrification in compost piles
- Leakage of CH_4 from AD reactors
- Collection and transportation of waste to transfer and treatment sites (indirect)

Source: 2006. *Guidelines for National Greenhouse Gas Inventories, Volume 5-Waste*, Geneva, , Switzerland: Intergovernmental Panel on Climate Change.

Biological treatment of solid waste

Composting and anaerobic digestion of organic waste

- Reduced volume in the waste material – stabilization of the waste
- Production of biogas for energy use
- End product can be recycled as a fertilizer or soil amendment

Composting

- large fraction of DOC in waste is converted to CO_2
- CH_4 and N_2O can both be formed during composting

Anaerobic digestion

- Biogas (CH_4 and CO_2)
- N_2O is assumed to be negligible

Source: Consultative Group of Experts (CGE) Training Materials for National Greenhouse Gas Inventories (Waste).

Biological treatment of solid waste: CH_4

$$CH_4 Emissions = \sum_i (M_i \bullet EF_i) \bullet 10^{-3} - R$$

CH_4 Emissions: total CH_4 emissions in inventory year, Gg CH_4
M_i : mass of organic waste treated by biological treatment type *i*, Gg
EF_i : emission factor for treatment *i*, g CH_4/kg waste treated
i : composting or anaerobic digestion
R : total amount of CH_4 recovered in inventory year, Gg CH_4. **If the recovered gas is flared, the emissions should be reported in Waste Sector**

Biological treatment of solid waste: N_2O

$$N_2O Emissions = \sum_i (M_i \bullet EF_i) \bullet 10^{-3}$$

N_2O Emissions: total N_2O emissions in inventory year, Gg N_2O

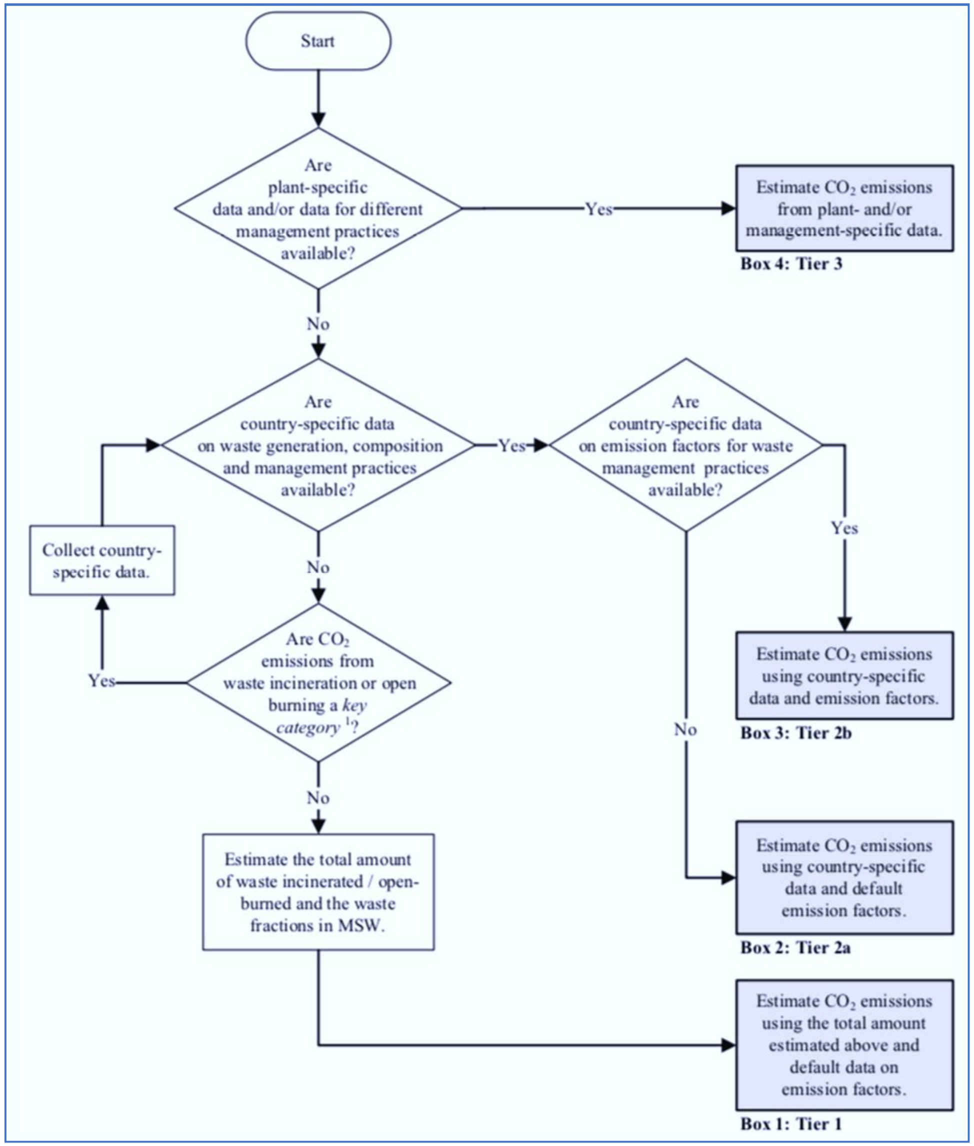
M_i : mass of organic waste treated by biological treatment type *i*, Gg

EF_i : emission factor for treatment *i*, g N_2O/kg waste treated

i : composting or anaerobic digestion

Incineration and open burning of waste

Tier selection decision tree



Estimation of the amount of fossil carbon is the most important factor determining the CO2 emissions as **only CO2 emissions of fossil origin** (e.g., plastics, certain textiles, rubber, liquid solvents, and waste oil) **should be included**

Incineration and open burning of waste: CO_2

Method based on total amount of waste combusted

$$CO_2 Emissions = \sum_i (SW_i \bullet dm_i \bullet CF_i \bullet FCF_i \bullet OF_i) \bullet 44/12$$

CO_2 Emissions: CO_2 emissions in inventory year, Gg/yr
SW_i : total amount of solid waste of type *i (wet weight) incinerated or open-burned, Gg/yr*
dm_i : dry matter content in the waste (wet weight) incinerated or open-burned, (fraction)
CF_i : fraction of carbon in the dry matter (total carbon content), (fraction)
FCF_i : fraction of fossil carbon in the total carbon, (fraction)
OF_i : oxidation factor, (fraction)
44/12 : conversion factor from C to CO_2
i : type of waste incinerated/open-burned such as MSW, industrial solid waste (ISW), sewage sludge, hazardous waste, clinical waste, etc.

Incineration and open burning of waste: CO_2

Method based on MSW composition

$$CO_2Emissions = MSW \bullet \sum_j (WF_j \bullet dm_j \bullet CF_j \bullet FCF_j \bullet OF_j) \bullet 44/12$$

CO_2 Emissions: CO_2 emissions in inventory year, Gg/yr
MSW : total amount of municipal solid waste as wet weight incinerated or open-burned, Gg/yr
WF_j : fraction of waste type/material of component ***j*** in the MSW (as wet weight incinerated or open-burned)
dm_j : dry matter content in the component j of the MSW incinerated or open-burned, (fraction)
CF_j : fraction of carbon in the dry matter (i.e., carbon content) of component ***j***
FCF_j : fraction of fossil carbon in the total carbon of component ***j***
OF_j : oxidation factor, (fraction)
44/12 : conversion factor from C to CO_2
j : component of the MSW incinerated/open-burned such as paper/cardboard, textiles, food waste, wood, garden (yard) and park waste, disposable nappies, rubber and leather, plastics, metal, glass, other inert waste

Calculating other emissions and amount of waste open-burned

CH4

$$CH_4 Emissions = \sum_i (IW_i \bullet EF_i) \bullet 10^{-6}$$

CH_4 Emissions: CH_4 emissions in inventory year, Gg/yr
IW_i : amount of solid waste of type ***i*** *incinerated or open-burned, Gg/yr*
EF_i : aggregate CH_4 emission factor, kg CH_4/Gg of waste
10^{-6} : conversion factor from kilogram to gigagram
i : category or type of waste incinerated/open-burned (MSW, ISW, hazardous waste, clinical waste, sewage sludge, etc.)

N2O

$$N_2O Emissions = \sum_i (IW_i \bullet EF_i) \bullet 10^{-6}$$

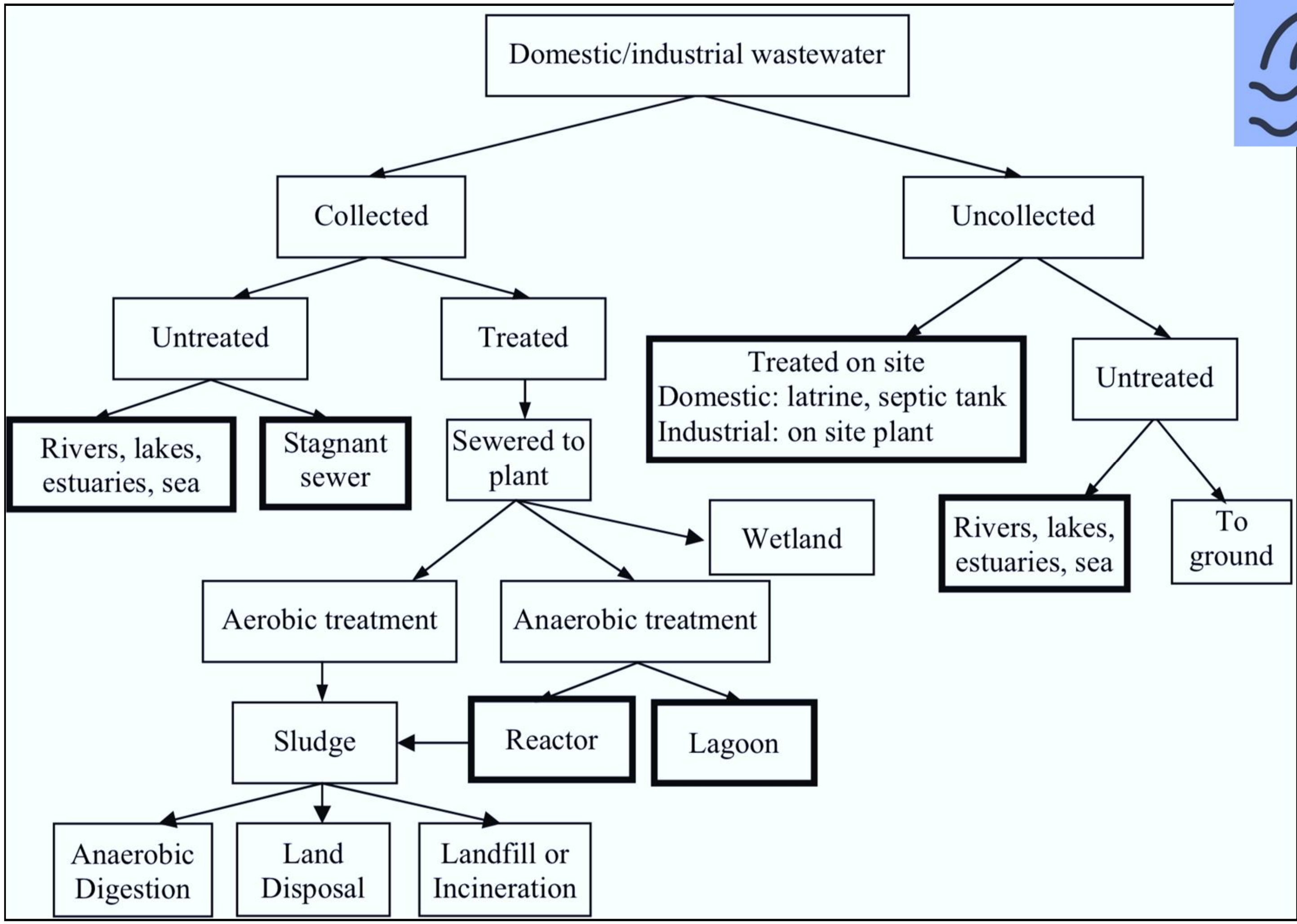
N_2O Emissions: N_2O emissions in inventory year, Gg/yr
IW_i : amount of incinerated/open-burned waste of type *i , Gg/yr*
EF_i : N_2O emission factor (kg N_2O/Gg of waste) for waste of type *i*
10^{-6} : conversion from kilogram to gigagram
i : category or type of waste incinerated/open-burned (MSW, ISW, hazardous waste, clinical waste, sewage sludge, etc.)

Amount of waste open-burned

$$MSW_B = P \bullet P_{frac} \bullet MSW_P \bullet B_{frac} \bullet 365 \bullet 10^{-6}$$

MSW_B : Total amount of municipal solid waste open-burned, Gg/yr
P : population (capita)
P_{frac} : fraction of population burning waste, (fraction)
MSW_P : per capita waste generation, kg waste/capita/day
B_{frac} : fraction of the waste amount that is burned relative to the total amount of waste treated
365 : number of days by year
10^{-6} : conversion factor from kilogram to gigagram

Wastewater treatment systems and discharge



Treatment and Discharge Systems and CH4 and N2O Generation Potential - domestic wastewater

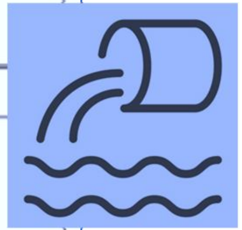


TABLE 6.1
CH_4 AND N_2O EMISSION POTENTIALS FOR WASTEWATER AND SLUDGE TREATMENT AND DISCHARGE SYSTEMS

			Types of treatment and disposal	CH_4 and N_2O emission potentials
Collected	Untreated		River discharge	Stagnant, oxygen-deficient rivers and lakes may allow for anaerobic decomposition to produce CH_4. Rivers, lakes and estuaries are likely sources of N_2O.
Collected	Untreated		Sewers (closed and under ground)	Not a source of CH_4/N_2O.
Collected	Untreated		Sewers (open)	Stagnant, overloaded open collection sewers or ditches/canals are likely significant sources of CH_4.
Collected	Treated	Aerobic treatment	Centralized aerobic wastewater treatment plants	May produce limited CH_4 from anaerobic pockets. Poorly designed or managed aerobic treatment systems produce CH_4. Advanced plants with nutrient removal (nitrification and denitrification) are small but distinct sources of N_2O.
Collected	Treated	Aerobic treatment	Sludge anaerobic treatment in centralized aerobic wastewater treatment plant	Sludge may be a significant source of CH_4 if emitted CH_4 is not recovered and flared.
Collected	Treated	Aerobic treatment	Aerobic shallow ponds	Unlikely source of CH_4/N_2O. Poorly designed or managed aerobic systems produce CH_4.
Collected	Treated	Anaerobic treatment	Anaerobic lagoons	Likely source of CH_4. Not a source of N_2O.
Collected	Treated	Anaerobic treatment	Anaerobic reactors	May be a significant source of CH_4 if emitted CH_4 is not recovered and flared.
Uncollected			Septic tanks	Frequent solids removal reduces CH_4 production.
Uncollected			Open pits/Latrines	Pits/latrines are likely to produce CH_4 when temperature and retention time are favourable.
Uncollected			River discharge	See above.

Equation to estimate CH4 emissions from domestic wastewater

The steps for *good practice* in inventory preparation for CH_4 from domestic wastewater are as follows:

Step 1: Use Equation 6.3 to estimate total organically degradable carbon in wastewater (TOW).

Step 2: Select the pathway and systems (See Figure 6.1) according to country activity data. Use Equation 6.2 to obtain the emission factor for each domestic wastewater treatment/discharge pathway or system.

Step 3: Use Equation 6.1 to estimate emissions, adjust for possible sludge removal and/or CH_4 recovery and sum the results for each pathway/system.

EQUATION 6.1
TOTAL CH_4 EMISSIONS FROM DOMESTIC WASTEWATER

$$CH_4\ Emissions = \left[\sum_{i,j}\left(U_i \bullet T_{i,j} \bullet EF_j\right)\right]\left(TOW - S\right) - R$$

Where:

CH_4 Emissions = CH_4 emissions in inventory year, kg CH_4/yr

TOW = total organics in wastewater in inventory year, kg BOD/yr

S = organic component removed as sludge in inventory year, kg BOD/yr

U_i = fraction of population in income group *i* in inventory year, See Table 6.5.

$T_{i,j}$ = degree of utilisation of treatment/discharge pathway or system, *j*, for each income group fraction *i* in inventory year, See Table 6.5.

i = income group: rural, urban high income and urban low income

j = each treatment/discharge pathway or system

EF_j = emission factor, kg CH_4 / kg BOD

R = amount of CH_4 recovered in inventory year, kg CH_4/yr

Default MCF values for domestic wastewater pathways (treatment)

Type of treatment and discharge pathway or system	Comments	MCF [1]	Range
Untreated system			
Sea, river and lake discharge	Rivers with high organics loadings can turn anaerobic.	0.1	0 – 0.2
Stagnant sewer	Open and warm	0.5	0.4 – 0.8
Flowing sewer (open or closed)	Fast moving, clean. (Insignificant amounts of CH_4 from pump stations, etc)	0	0
Treated system			
Centralized, aerobic treatment plant	Must be well managed. Some CH_4 can be emitted from settling basins and other pockets.	0	0 – 0.1
Centralized, aerobic treatment plant	Not well managed. Overloaded.	0.3	0.2 – 0.4
Anaerobic digester for sludge	CH_4 recovery is not considered here.	0.8	0.8 – 1.0
Anaerobic reactor	CH_4 recovery is not considered here.	0.8	0.8 – 1.0
Anaerobic shallow lagoon	Depth less than 2 metres, use expert judgment.	0.2	0 – 0.3
Anaerobic deep lagoon	Depth more than 2 metres	0.8	0.8 – 1.0
Septic system	Half of BOD settles in anaerobic tank.	0.5	0.5
Latrine	Dry climate, ground water table lower than latrine, small family (3-5 persons)	0.1	0.05 – 0.15

Industrial wastewater CH4 emissions

The general equation to estimate CH_4 emissions from industrial wastewater is as follows:

EQUATION 6.4
TOTAL CH_4 EMISSIONS FROM INDUSTRIAL WASTEWATER

$$CH_4\ Emissions = \sum_i \left[\left(TOW_i - S_i \right) EF_i - R_i \right]$$

Where:

CH_4 Emissions = CH_4 emissions in inventory year, kg CH_4/yr

TOW_i = total organically degradable material in wastewater from industry i in inventory year, kg COD/yr

i = industrial sector

S_i = organic component removed as sludge in inventory year, kg COD/yr

EF_i = emission factor for industry i, kg CH_4/kg COD for treatment/discharge pathway or system(s) used in inventory year

If more than one treatment practice is used in an industry this factor would need to be a weighted average.

R_i = amount of CH_4 recovered in inventory year, kg CH_4/yr

Domestic wastewater N_2O emissions

EQUATION 6.7
N_2O EMISSIONS FROM WASTEWATER EFFLUENT

$$N_2O\ Emissions = N_{EFFLUENT} \bullet EF_{EFFLUENT} \bullet 44/28$$

Where:

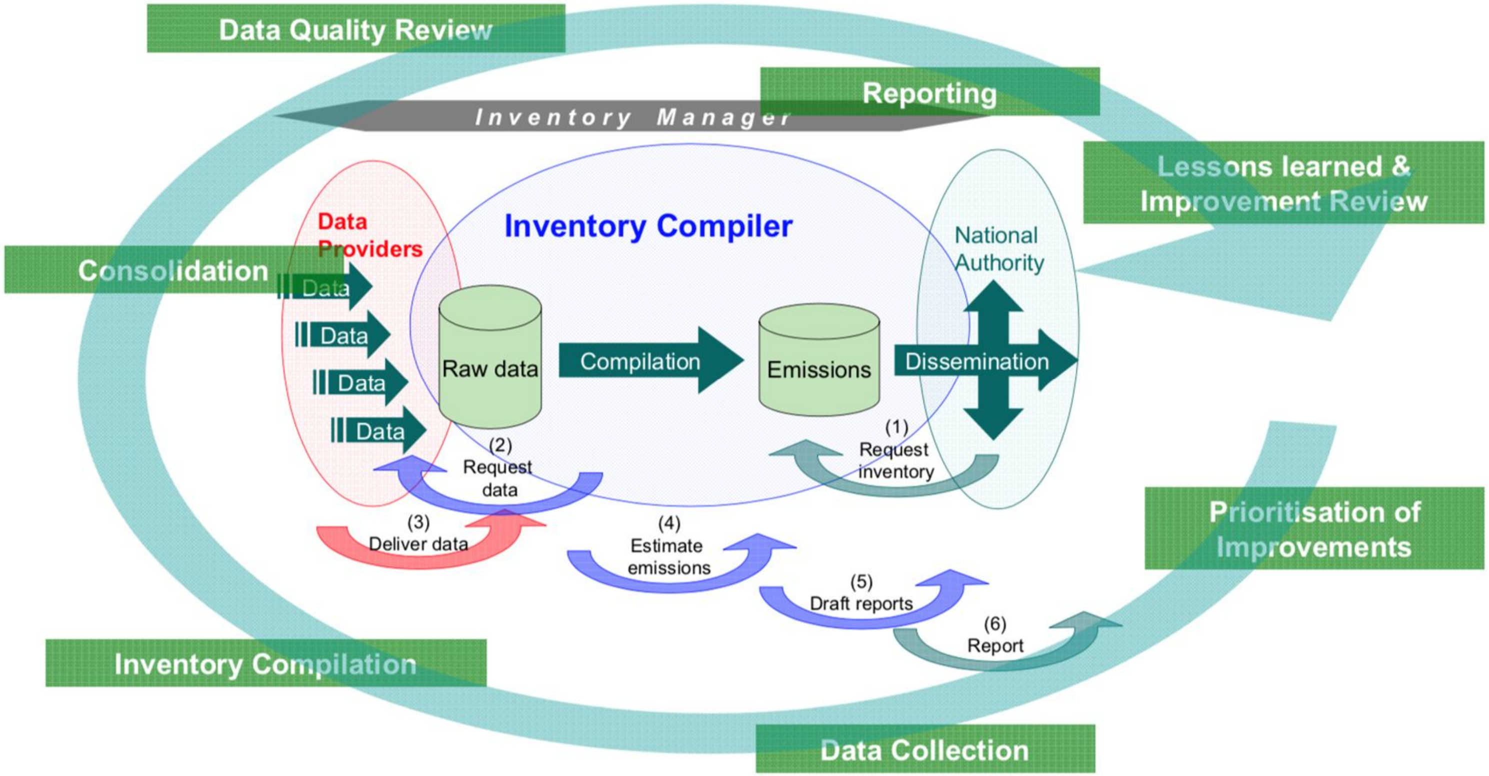
N_2O emissions = N_2O emissions in inventory year, kg N_2O/yr

$N_{EFFLUENT}$ = nitrogen in the effluent discharged to aquatic environments, kg N/yr

$EF_{EFFLUENT}$ = emission factor for N_2O emissions from discharged to wastewater, kg N_2O-N/kg N

The factor 44/28 is the conversion of kg N_2O-N into kg N_2O.

Aspects of Inventory Management



Source: EMEP/EEA emission inventory guidebook 2009

Emissions scenario projections and modeling

Paris Agreement calls on countries to deliver long-term strategies (LTSs) for decarbonization in pursuit of the "well below 2°C" goal.

- Models can assist in the creation of LTS by offering points of engagement with: national leadership, stakeholders, domestic and international audiences
- Models offer way to organize thoughts and understanding implications of alternate pathways, connecting core drivers to possible outcomes
- Models can produce conditional forecasts based on where countries currently are, and what they feel their choices might be

Incorporation of Measurement, Reporting a Verification (MRV)

TYPE OF MRV	MEASUREMENT		REPORTING	VERIFICATION[b]
	Method[a]	Data Requirements		
National GHG inventory	■ IPCC Guidelines for National Greenhouse Gas Inventories	■ Activity data and emission factor ■ Data requirements associated with calculating emissions from some sources, particularly non-energy sources (i.e., AFOLU), can be significantly more complicated ■ Data from continuous emissions monitoring system (CEMS) where feasible	■ To the UNFCCC as part of: □ National Inventory Reports for developed countries □ National Communications for developed and developing countries □ Biennial Reports (BR) for developed countries, and Biennial Update Reports (BURs) for developing countries[c] ■ Countries may also develop inventories solely for domestic objectives	■ Prescribed by UNFCCC—International Consultation and Analysis (ICA) for developing countries, and International Assessment and Review (IAR) for developed countries[d] ■ The Paris Agreement sets up a technical expert review process for the information provided by countries

Sources: MRV 101: Understanding Measurement, Reporting and Verification of Climate Change Mitigation, WRI 2016

Organizations working on waste and wastewater

SOLID WASTE

- ISWA - International Solid Waste Association www.iswa.org
    - CAUES - China Association of Urban Environmental Sanitation http://chinagate.cn/english/1950.htm
    - WMAM- Waste Management Association of Malaysia http://www.wmam.org
    - WMRAS - Waste Management and Recycling Association of Singapore http://www.wmras.org.sg
    - ICWM - Institute of Chartered Waste Managers http://icwm.ac.in
    - InSWA - Indonesia Solid Waste Association http://inswa.or.id
    - JWMA - Japan Waste Management Association http://www.jwma-tokyo.or.jp
    - KSWM - Korea Society of Waste Management http://www.kswm.or.kr/english/html/sub_01.asp
- Climate and Clean Air Coalition (CCAC) Waste Initiative http://ccacoalition.org/en/initiatives/waste
- Global Methane Initiative (GMI) / Landfill Methane Outreach Program (USEPA) https://www.globalmethane.org
- Partnership on Transparency in the Paris Agreement https://www.transparency-partnership.net

WASTEWATER

- International Water Association (IWA) http://www.iwa-network.org
- Water and Wastewater Companies for Climate Mitigation http://wacclim.org

Additional internet resources

- CCAC waste knowledge platform: http://www.waste.ccacoalition.org
- GMI Wastewater Biogas Assessment Technology Tool https://www.globalmethane.org/sectors/technicalgroup.aspx?s=ww
- GMI China Landfill Gas Model https://www.globalmethane.org/partners/country.aspx?country=china&r=true / 工作表 (Excel)
- GMI Philippines Landfill Gas Model https://www.globalmethane.org/partners/country.aspx?country=philippines&r=true
- GMI Thailand Landfill Gas Model https://www.globalmethane.org/partners/country.aspx?country=thailand&r=true / คู่มือผู้ใช้งาน (MS Word)
- IPCC CGE Training Materials (GHG inventory software/waste trainings) https://unfccc.int
- IPCC Emissions Factor Database https://www.ipcc-nggip.iges.or.jp/EFDB/main.php
- IPCC Vol. 5 Waste: https://www.ipcc-nggip.iges.or.jp/public/2006gl/vol5.html
- USAID GHG Inventories and Accounting http://www.lowemissionsasia.org/what-we-do/ghg-inventories-and-accounting/
- USEPA Landfill Gas Emissions Model https://www.epa.gov/catc/clean-air-technology-center-products#software

Thank you!

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