

Climate MRV for Africa – Phase 2 Development of National GHG Inventory Incineration and Open Burning of Solid Waste



NIRAS
Lead partner

GreenStream

TÜVRheinland[®]
Precisely Right.

camco
clean energy

Project of the European Commission DG Clima Action

EuropeAid/136245/DH/SER/MULTI

Amr Osama Abdel-Aziz, Assen Gasharov, Mike Bess
and Laura Lahti

Team Leader and Key Experts

January 2017

Incineration and Open Burning of Waste



Waste incineration



Open burning of waste

Types of Waste

- Municipal solid waste (MSW)
- Industrial waste
- Hazardous waste
- Clinical waste
- Sewage sludge



Incineration and Open Burning

- Amount of fossil carbon is the most important factor determining the CO₂ emissions
- **Only CO₂ emissions of fossil origin should be included in emission estimates (plastics, certain textiles, rubber, liquid solvents, and waste oil)**
- CH₄ emissions result from incomplete combustion of waste and can be affected by temperature, residence time, and air to waste ratio
- N₂O emissions are mainly determined by technology, combustion temperature and waste composition
- GHG emissions from incineration with energy recovery are reported in the Energy Sector

Incineration and Open Burning - CO₂

EQUATION 5.1

CO₂ EMISSION ESTIMATE BASED ON THE TOTAL AMOUNT OF WASTE COMBUSTED

$$CO_2 \text{ Emissions} = \sum_i (SW_i \cdot dm_i \cdot CF_i \cdot FCF_i \cdot OF_i) \cdot 44/12$$

Where:

CO₂ Emissions = CO₂ 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 CO₂

i = type of waste incinerated/open-burned specified as follows:

Incineration and Open Burning - CO₂

EQUATION 5.2

CO₂ EMISSION ESTIMATE BASED ON THE MSW COMPOSITION

$$CO_2 \text{ Emissions} = MSW \cdot \sum_j (WF_j \cdot dm_j \cdot CF_j \cdot FCF_j \cdot OF_j) \cdot 44/12$$

Where:

CO₂ Emissions = CO₂ 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 CO₂

with: $\sum_j WF_j = 1$

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.

Incineration and Open Burning - CO₂

TABLE 5.1
OVERVIEW OF DATA SOURCES OF DIFFERENT TIER LEVELS

Data sources	Total waste amount (W)	Waste fraction (WF): % of each component mainly for MSW	Dry matter content (dm)	Carbon fraction (CF)	Fossil carbon fraction (FCF)	Oxidation factor (OF)
Tiers						
Tier 3	plant- / management-specific	plant- / management-specific	plant- / management-specific	plant- / management-specific	plant- / management-specific	plant- / management-specific
Tier 2b	country-specific	country-specific	country-specific	country-specific	default / country-specific	default / country-specific
Tier 2a	country-specific	country-specific	default	default	default	default
Tier 1	default / country-specific	default	default	default	default	default

Incineration and Open Burning - CO₂

TABLE 5.2
DEFAULT DATA FOR CO₂ EMISSION FACTORS FOR INCINERATION AND OPEN BURNING OF WASTE

Parameters	Management practice	MSW	Industrial Waste (%)	Clinical Waste (%)	Sewage Sludge (%) Note 4	Fossil liquid waste (%) Note 5
Dry matter content in % of wet weight		see Note 1	NA	NA	NA	NA
Total carbon content in % of dry weight		see Note 1	50	60	40 – 50	80
Fossil carbon fraction in % of total carbon content		see Note 2	90	40	0	100
Oxidation factor in % of carbon input	incineration	100	100	100	100	100
	Open- burning (see Note 3)	58	NO	NO	NO	NO

Incineration and Open Burning – CH₄

EQUATION 5.4

CH₄ EMISSION ESTIMATE BASED ON THE TOTAL AMOUNT OF WASTE COMBUSTED

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

CH₄ Emissions = CH₄ emissions in inventory year, Gg/yr

IW_i = amount of solid waste of type *i* incinerated or open-burned, Gg/yr

EF_i = aggregate CH₄ emission factor, kg CH₄/Gg of waste

10⁻⁶ = conversion factor from kilogram to gigagram

i = category or type of waste incinerated/open-burned, specified as follows:

MSW: municipal solid waste, ISW: industrial solid waste, HW: hazardous waste,
CW: clinical waste, SS: sewage sludge, others (that must be specified)

- **Tier 2 – Country specific values, Tier 3 – plant specific values**

Incineration and Open Burning – CH₄

TABLE 5.3
CH₄ EMISSION FACTORS FOR INCINERATION OF MSW

Type of incineration/technology		CH ₄ Emission Factors (kg/Gg waste incinerated on a wet weight basis)
Continuous incineration	stoker	0.2
	fluidised bed ^{Note1}	~0
Semi-continuous incineration	stoker	6
	fluidised bed	188
Batch type incineration	stoker	60
	fluidised bed	237

Note 1: In the study cited for this emission factor, the measured CH₄ concentration in the exhaust air was lower than the concentration in ambient air.

Source: Greenhouse Gas Inventory Office of Japan, GIO 2004.

Incineration and Open Burning – N₂O

EQUATION 5.5

N₂O EMISSION ESTIMATE BASED ON THE WASTE INPUT TO THE INCINERATORS

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

Where:

N₂O Emissions = N₂O emissions in inventory year, Gg/yr

IW_i = amount of incinerated/open-burned waste of type *i*, Gg/yr

EF_i = N₂O emission factor (kg N₂O/Gg of waste) for waste of type *i*

10⁻⁶ = conversion from kilogram to gigagram

i = category or type of waste incinerated/open-burned, specified as follows:

MSW: municipal solid waste, ISW: industrial solid waste, HW: hazardous waste,
CW: clinical waste, SS: sewage sludge, others (that must be specified)

- **Tier 2 – Country specific values, Tier 3 – plant specific values**

Incineration and Open Burning – N₂O

TABLE 5.6
DEFAULT N₂O EMISSION FACTORS FOR DIFFERENT TYPES OF WASTE AND MANAGEMENT PRACTICES

Type of waste	Technology / Management practice	Emission factor (g N ₂ O / t waste)	weight basis
MSW	continuous and semi-continuous incinerators	50	wet weight
MSW	batch-type incinerators	60	wet weight
MSW	open burning	150	dry weight
Industrial waste	all types of incineration	100	wet weight
Sludge (except sewage sludge)	all types of incineration	450	wet weight
Sewage sludge	incineration	990	dry weight
		900	wet weight

Source: Expert judgement by lead authors of this chapter of *2006 Guidelines*

Amount of Waste Open Burned

EQUATION 5.7

TOTAL AMOUNT OF MUNICIPAL SOLID WASTE OPEN-BURNED

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

Where:

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, (fraction)

365 = number of days by year

10^{-6} = conversion factor from kilogram to gigagram

Thank you!

Amr Osama Abdel-Aziz, Assen Gasharov, Mike Bess and Laura Lahti