# Waste Sector

## Quality Assurance of the National Greenhouse Gas Inventory Management System and National Greenhouse Gas Inventories of South Africa

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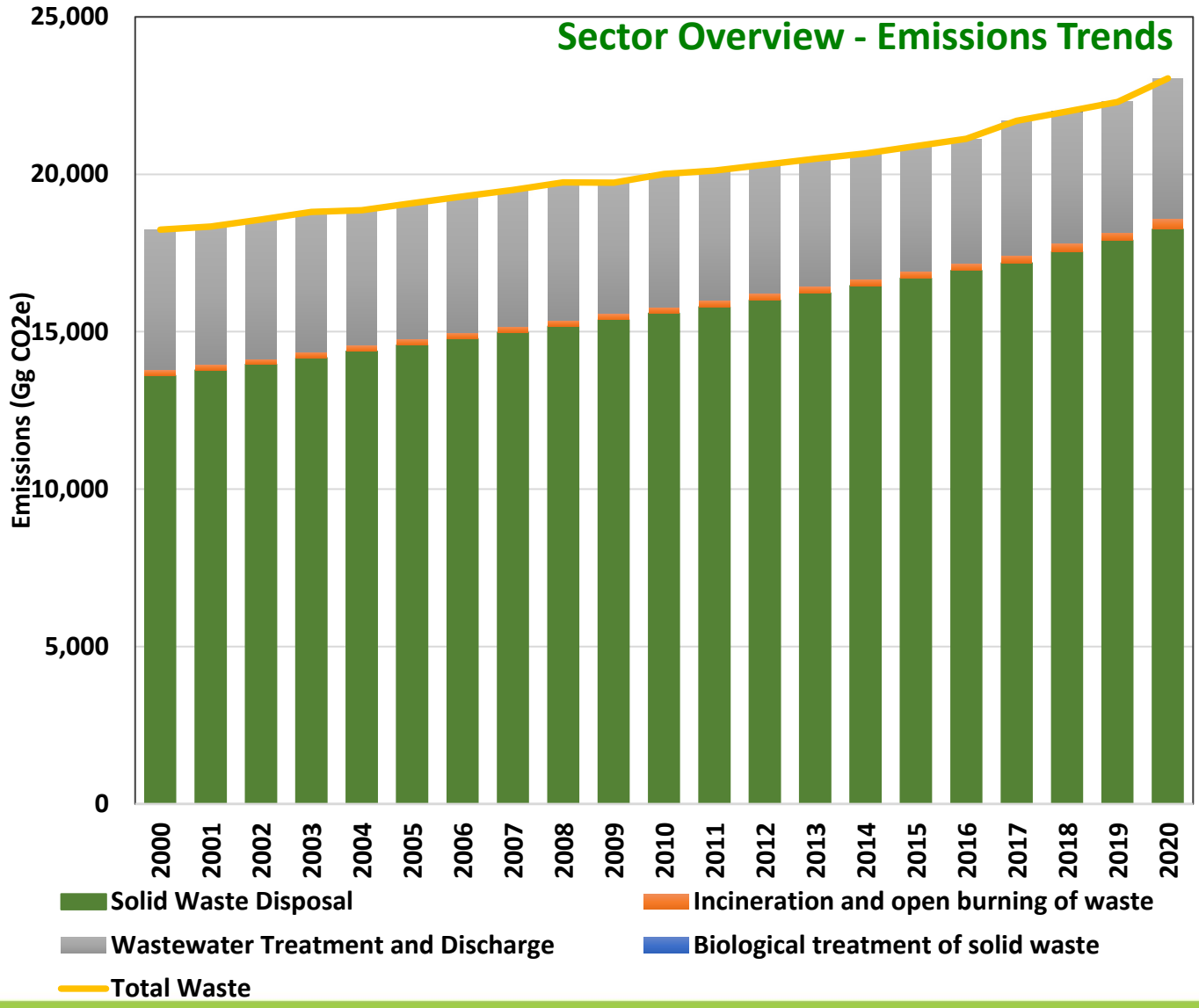
## Overview of 2020 Emissions for the Waste Sector

- Total 2020 *Waste* sector emissions were 23 046 Gg $CO_2$e. 4.9 % ex FOLU
- Main contributor → *Solid Waste Disposal* at 79.2 %.
- Followed by *Wastewater Treatment & Discharge* at 19.3 %
- Waste emissions increased by 26 % since 2000



# Waste sector

## Sector Overview: Completeness

- 4A Solid waste disposal;
  - $CH_4$ emissions from Managed Solid Waste Disposal Sites
- 4B Biological Treatment of Solid Waste, $CH_4$ and $N_2O$ emissions from:
  - from Composting **(*New Source*)**
  - Anaerobic Digestion at Biogas Facilities **(*New Source*)**
- 4C Open burning of waste; and
- 4D Wastewater treatment and discharge, $CH_4$ and indirect $N_2O$ emissions from treatment of wastewater.
  - Domestic Wastewater treatment and discharge.
  - Industrial Wastewater treatment and discharge **(*New Source*)**

| NE, IE or NO | IPCC Category | Activity | Comments |
|---|---|---|---|
| **NE** | 4C1 | $CO_2$, $CH_4$ and $N_2O$ from waste incineration | Insufficient data to include |

# Waste sector

## Sector Overview: Key Categories

| IPCC Code | Category | GHG | Identification Criteria |
|---|---|---|---|
| 4A | Solid waste disposal | $CH_4$ | L,T |
| 4D | Wastewater treatment & discharge | $CH_4$ | L |

## Sector Overview: Recalculations & Improvements

Various improvements were incorporated into the Waste sector:

- Waste generation rate per person was adjusted from 578 kg/cap/yr in previous submissions to 398 kg/cap/yr.
- Waste generation rate per GDP value, for purposes of estimating the amount of industrial waste generated was adjusted from 8 Gg waste/GDP/yr in previous submissions to 0.4 waste/GDP/yr in the current submission.
- Amount sent to SWDS adjusted to 76% for MSW and 85% for Industrial waste to reflect changes in penetration of recycling and the evolution of other forms of waste management and/or treatment.

# SECTOR SPECIFIC ASPECTS: WASTE SECTOR – 4A - SOLID WASTE DISPOSAL

# Sector Specific aspects- Waste Sector

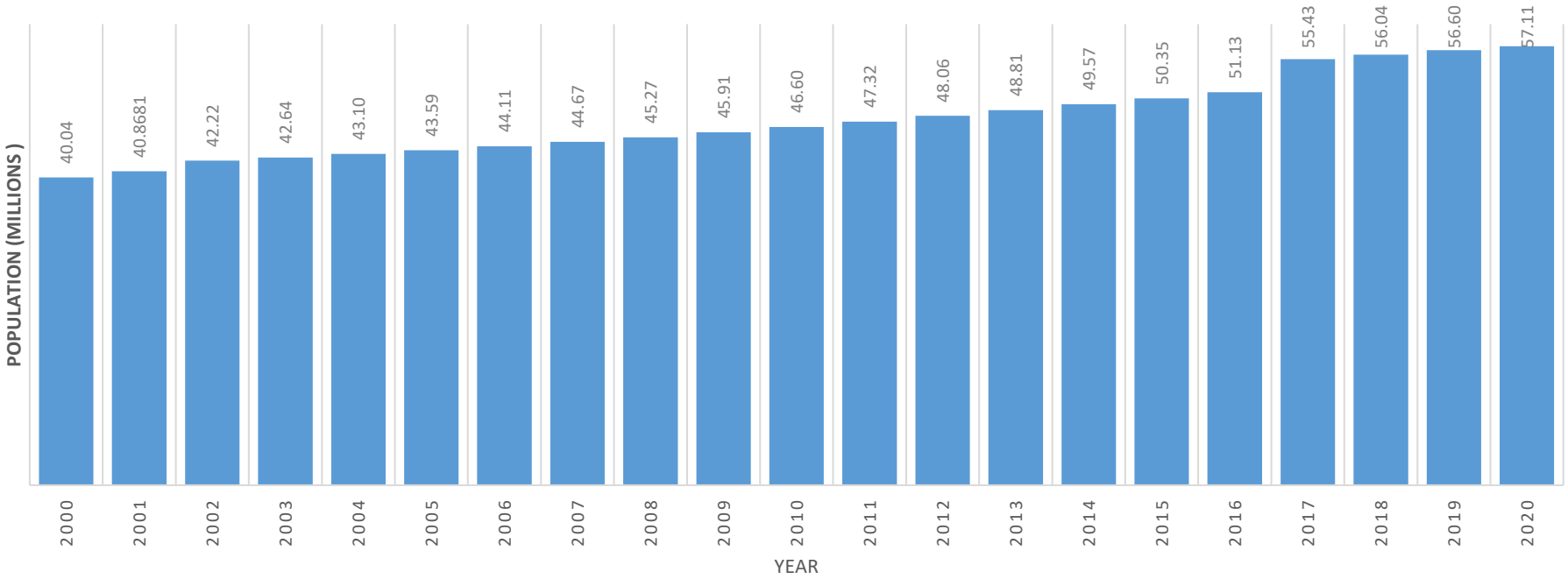
## Solid Waste Disposal – Overview

| Solid Waste Disposal | |
|---|---|
| Year | Emissions (Gg $CO_2e$) |
| 2000 | 13 610.5 |
| 2001 | 13 782.7 |
| 2002 | 13 965.2 |
| 2003 | 14 175.1 |
| 2004 | 14 379.1 |
| 2005 | 14 579.6 |
| 2006 | 14 778.3 |
| 2007 | 14 976.3 |
| 2008 | 15 175.3 |
| 2009 | 15 376.6 |
| 2010 | 15 581.4 |
| 2011 | 15 791.9 |
| 2012 | 16 008.4 |
| 2013 | 16 230.9 |
| 2014 | 16 462.4 |
| 2015 | 16 698.7 |
| 2016 | 16 939.0 |
| 2017 | 17 183.9 |
| 2018 | 17 551.8 |
| 2019 | 17 908.7 |
| 2020 | 18 252.8 |

- *Solid waste disposal* produced 18 253 Gg $CO_2e$ in 2020, which was all from $CH_4$ emissions.
- It contributed 79.2% to the total *Waste* sector emissions.
- Emissions increased by 34.1% from 2000 – 2020
- The main driver of this increase is the population numbers.

# Sector Specific aspects- Waste Sector

## (Solid Waste Disposal – Data Sources: Activity Data)




| Sub-category | Activity data | Data source |
|---|---|---|
| Solid waste disposal | Population data | Statistics SA (2015); |
| | | UN (2012) |
| | Waste composition | IPCC 2006, and 2019 IPCC Refinement |
| | GDP | World bank |

# Sector Specific aspects- Waste Sector

## Solid Waste Disposal – Factors Used

| Factor | Sub-category | Value | Unit |
|---|---|---|---|
| DOC (degradable organic carbon) | Bulk MSW | 0.2 | Weight fraction (wet basis) |
| | Industrial waste | 0.15 | |
| | Sludge waste | 0.05 | |
| DOCf (fraction of DOC dissimilated) | | 0.05 | Fraction |
| Methane generation rate constant | Bulk MSW | 0.05 | $Years^{-1}$ |
| | Industrial waste | 0.05 | |
| | Sewage sludge | 0.06 | |
| Methane correction factor (MCF) | Unmanaged, shallow | 0.4 | Unitless |
| | Unmanaged, deep | 0.8 | |
| | Managed | 1 | |
| | Managed, semi-aerobic | 0.5 | |
| | Uncategorized | 0.6 | |
| Fraction of methane in generated landfill gas (F) | | 0.5 | Fraction |
| Oxidation factor (OF) | | 0 | Unitless |

## Solid Waste Disposal – Key Assumptions

The key assumptions applied in this method were:

- percentage of MSW going into landfills was assumed to be constant (76%) throughout the time series 2000 – 2020
- percentage of Industrial Solid Waste going into landfills was assumed to be constant (85%) throughout the time series 2000 – 2020
- Composition of waste going into SWDS was assumed to be 24 % food, 0% garden, 14.5% paper, 0% wood, 5,5% textile, 0% nappies and 56% plastic or other inert substance (default IPCC Regional values – 2019 Refinement)
- waste generation rate per GDP (Gg/$m GDP/yr) was assumed to be constant (0,4 tonnes/per unit of GDP in US dollar) throughout the time series).

# Sector Specific aspects- Waste Sector

## Solid Waste Disposal – Planned Improvements

(i) Obtain data on the quantities of waste disposed of into managed and unmanaged landfills including its composition;

(ii) Improve the classification of landfill sites

(iii) Improve the reporting of economic data (e.g. annual growth) to include different population groups. The assumption that GDP growth is evenly distributed (using a computed mean) across all the population groups is highly misleading, and leads to exacerbated margins of error;

(iv) Obtain information on population distribution trends between rural and urban settlements as a function of income; and

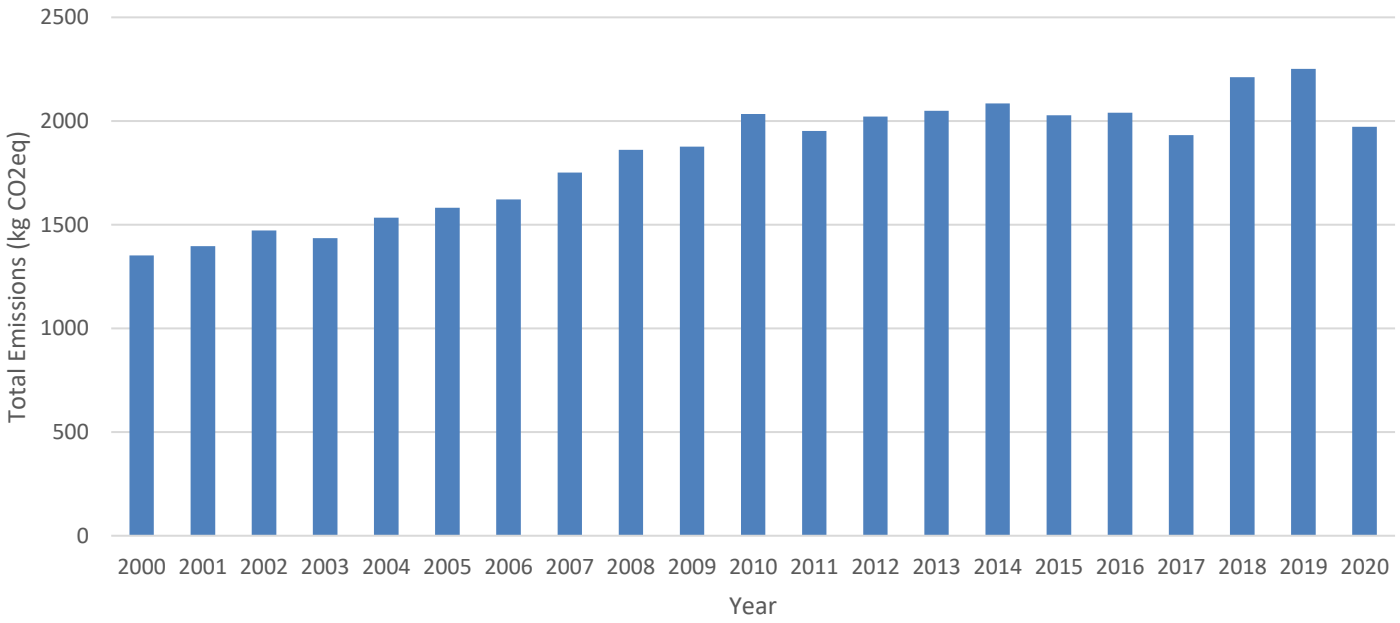
(v) Conduct a study to trace waste streams and obtain more information on the bucket system which is still widely used in South Africa.

(vi) Collect data on $CH_4$ recovery at SWDS based on metering data.

# SECTOR SPECIFIC ASPECTS: WASTE SECTOR
# 4B - BIOLOGICAL TREATMENT OF SOLID WASTE

# Sector Specific aspects- Waste Sector

## Biological Treatment of Solid Waste – Overview




- *Biological Treatment of Solid Waste* produced 0.002 Gg $CO_2e$ in 2020.
- This includes $CH_4$ emissions from both and only $N_2O$ from composting.
- This sub-category is considered insignificant.

# Sector Specific aspects- Waste Sector

## Biological Treatment of Solid Waste – Data Sources: Activity Data

| Period | Biological Treatment System | Waste Treated (Gg) |
|---|---|---|
| 2000 | Composting | 2677 |
| 2001 | | 2781 |
| 2002 | | 2955 |
| 2003 | | 2866 |
| 2004 | | 3096 |
| 2005 | | 3215 |
| 2006 | | 3333 |
| 2007 | | 3622 |
| 2008 | | 3957 |
| 2009 | | 3803 |
| 2010 | | 4052 |
| 2011 | | 4156 |
| 2012 | | 4315 |
| 2013 | | 4386 |
| 2014 | | 4409 |
| 2015 | | 4335 |
| 2016 | | 4357 |
| 2017 | | 4099 |
| 2018 | | 4741 |
| 2019 | | 4842 |

- *Data from Sanitation Waste Pathways study*
  - *Composting*
  - *Anaerobic digestion*
- *For composting only includes Industrial Solid Waste from:*
  - *Meat & poultry*
  - *Plastics & Resins*
  - *Organic chemicals*
  - *Soap & detergents*
  - *Starch production*
  - *Vegetable oils*
  - *Vegetables, fruits & juices*

# Sector Specific aspects- Waste Sector

## Biological Treatment of Solid Waste – Data Sources: Activity Data

| Period | Biological Treatment System | Waste Treated (Gg) | $CH_4$ Recovered |
|---|---|---|---|
| 2000 | Anaerobic digestion at biogas facilities | 5662 | 10.75759 |
| 2001 | | 5732 | 10.88992 |
| 2002 | | 5838 | 11.09145 |
| 2003 | | 5808 | 11.03606 |
| 2004 | | 5923 | 11.25376 |
| 2005 | | 5888 | 11.18803 |
| 2006 | | 5729 | 10.88481 |
| 2007 | | 5980 | 11.36284 |
| 2008 | | 5415 | 10.28811 |
| 2009 | | 7118 | 13.52474 |
| 2010 | | 8324 | 15.81632 |
| 2011 | | 5631 | 10.69833 |
| 2012 | | 5726 | 10.87883 |
| 2013 | | 5691 | 10.81221 |
| 2014 | | 6260 | 11.89394 |
| 2015 | | 5698 | 10.82596 |
| 2016 | | 5753 | 10.93055 |
| 2017 | | 5683 | 10.79762 |
| 2018 | | 6078 | 11.54978 |
| 2019 | | 6054 | 11.50436 |

- *For anaerobic digestion only Industrial Solid Waste from:*
  - *Meat & poultry*
  - *Beer & malt*
  - *Dairy*
  - *Petroleum refining*
  - *Hazardous waste*

# Sector Specific aspects- Waste Sector

## Biological Treatment of Solid Waste – Factors Used

| | $CH_4$ Emission Factors (g $CH_4$/kg waste treated) | $N_2O$ Emission Factors (g $N_2O$/kg waste treated) |
|---|---|---|
| Composting | 10 | 0.6 |
| Anaerobic Digestion at Biogas Facilities | 2 | Assumed negligible |

## Biological Treatment of Solid Waste – Context & Assumptions

- Only emissions from biological treatment of Industrial Solid Waste have been taken into account.
- Biological treatment of Municipal Solid Waste is excluded.
- As more data is collected on the amount of MSW that undergoes biological treatment, this will be included in the inventory.

# SECTOR SPECIFIC ASPECTS: WASTE SECTOR
# 4C - INCINERATION & OPEN BURNING OF WASTE

# Sector Specific aspects- Waste Sector

## Incineration & Open Burning of Waste – Overview

| Incineration and open burning of waste | |
|---|---|
| Year | Emissions (Gg CO2e) |
| 2000 | 176.1 |
| 2001 | 179.7 |
| 2002 | 185.7 |
| 2003 | 187.5 |
| 2004 | 189.5 |
| 2005 | 191.7 |
| 2006 | 194.0 |
| 2007 | 196.4 |
| 2008 | 199.1 |
| 2009 | 201.9 |
| 2010 | 205.0 |
| 2011 | 208.1 |
| 2012 | 211.4 |
| 2013 | 214.7 |
| 2014 | 218.0 |
| 2015 | 221.4 |
| 2016 | 224.9 |
| 2017 | 250.7 |
| 2018 | 254.1 |
| 2019 | 257.5 |
| 2020 | 334.9 |

- *Open burning* produced 335 Gg $CO_2e$ in 2020.
- This is 1.5 % of total Waste Sector Emissions
- Emissions were 10.4% $CO_2$ (35 Gg $CO_2e$), 66.8% $CH_4$ (223 Gg $CO_2e$) and 22.8% $N_2O$ (76 Gg $CO_2e$).
- Emissions in this category increased by 90.2% (159 Gg $CO_2e$) between 2000 and 2020.

# Sector Specific aspects- Waste Sector

## Incineration & Open Burning of Waste– Data Sources: Activity Data

| Sub-category | Activity data | Data source |
|---|---|---|
| Open burning of waste | Population data | Statistics SA (2015); |
| | | UN (2012) |
| | Fraction of population burning waste | Assumption based on population without access to waste collection services |

Only open burning currently considered in this sub-category

# Sector Specific aspects- Waste Sector

## Incineration & Open Burning of Waste– Factors Used

| Sub-category | Value | Unit | Source |
|---|---|---|---|
| **Dry matter content** | | | |
| *Food* | *0.4* | fraction | IPCC 2006 |
| *Garden* | *0.4* | | |
| *Paper* | *0.9* | | |
| *Wood* | *0.85* | | |
| *Textile* | *0.8* | | |
| *Nappies* | *0.4* | | |
| *Plastics, other inert* | *0.9* | | |
| **Fraction of carbon in dry matter** | | | |
| *Food* | *0.38* | fraction | IPCC 2006 |
| *Garden* | *0.49* | | |
| *Paper* | *0.46* | | |
| *Wood* | *0.5* | | |
| *Textile* | *0.5* | | |
| *Nappies* | *0.7* | | |
| *Plastics, other inert* | *0.03* | | |
| **Fraction of fossil C in total carbon** | | | |
| *Food* | *0* | fraction | IPCC 2006 |
| *Garden* | *0* | | |
| *Paper* | *0.01* | | |
| *Wood* | *0* | | |
| *Textile* | *0.2* | | |
| *Nappies* | *0.1* | | |
| *Plastics, other inert* | *1.0* | | |
| **Oxidation factor** | 0.58 | fraction | IPCC 2006 |
| **$CH_4$ emission factor** | 6500 | g/t MSW | IPCC 2006 |
| **$N_2O$ emission factor** | 150 | G $N_2O$/t waste | IPCC 2006 |

# Sector Specific aspects- Waste Sector

## Incineration & Open Burning of Waste – Key Assumptions

In South Africa open burning of waste is considered in two cases,

- Where population do not have access to formal waste collection services. It is assumed that this portion of the population burn its waste openly.
- Small percentage of formal landfill sites who practice open burning as a means to manage waste volumes at SWDS.

- The fraction of population carrying out open-burning was estimated at 9% (Expert Judgement).

## Incineration & Open Burning of Waste – Planned Improvements

Collection of activity data on amounts of waste incinerated, by category of waste and the technologies used to incinerate waste in South Africa.

# SECTOR SPECIFIC ASPECTS: WASTE SECTOR
# 4D – WASTEWATER TREATMENT & DISCHARGE

# Sector Specific aspects- Waste Sector

## Wastewater Treatment & Discharge – Overview

| Wastewater Treatment and Discharge | |
|---|---|
| Year | Emissions (Gg $CO_2e$) |
| 2000 | 4 454.6 |
| 2001 | 4 381.2 |
| 2002 | 4 415.5 |
| 2003 | 4 440.5 |
| 2004 | 4 290.2 |
| 2005 | 4 314.2 |
| 2006 | 4 323.6 |
| 2007 | 4 329.0 |
| 2008 | 4 367.7 |
| 2009 | 4 153.7 |
| 2010 | 4 220.7 |
| 2011 | 4 114.0 |
| 2012 | 4 087.2 |
| 2013 | 4 045.6 |
| 2014 | 3 980.0 |
| 2015 | 3 976.2 |
| 2016 | 3 959.5 |
| 2017 | 4 264.7 |
| 2018 | 4 183.2 |
| 2019 | 4 133.1 |
| 2020 | 4 458.1 |

- *Wastewater treatment and discharge* contributed 4 458 Gg $CO_2e$.
- This was 19.3 % of total Waste Sector emissions
- The contribution from *Wastewater treatment and discharge* has remained stable throughout the time series.
- This is largely due to similar increases and decreases in Domestic and Industrial wastewater emissions.

# Sector Specific aspects- Waste Sector

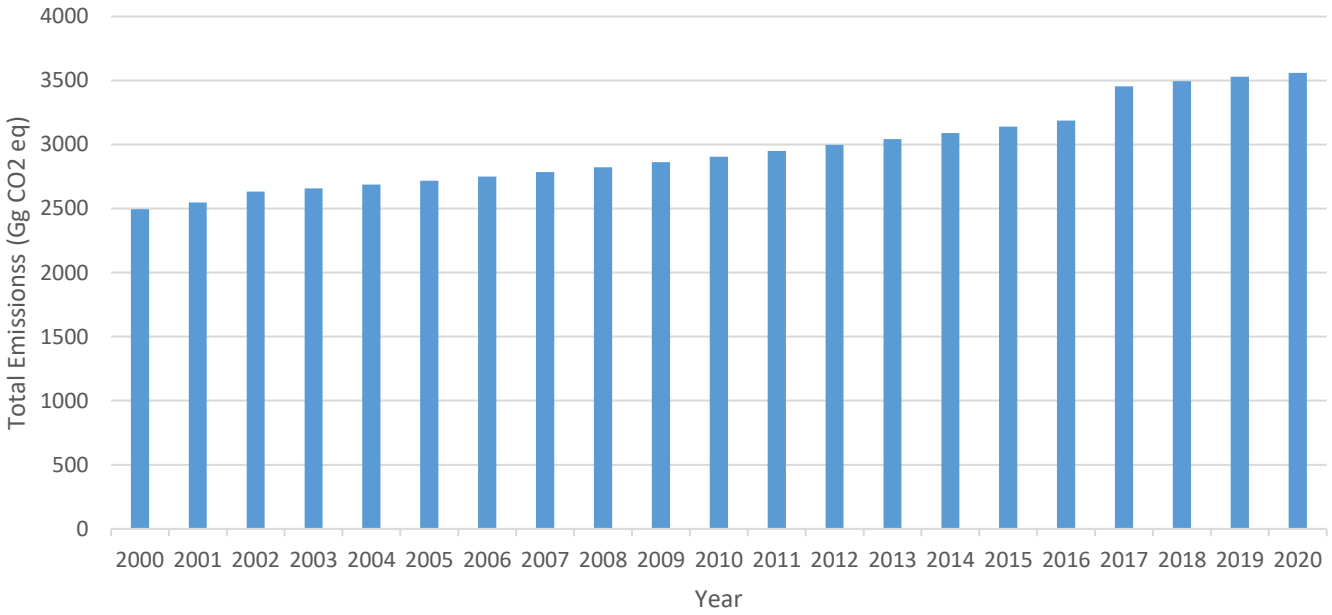
## Wastewater Treatment & Discharge – Data Sources: Activity Data

| Sub-category | Activity data | Data source |
|---|---|---|
| Wastewater treatment and discharge | Population data | Statistics SA (2015); |
| | | UN (2012) |
| | Split of population by income group | Statistics SA (2015) |
| | BOD generation rates per treatment type | IPCC 2006 |
| | Per capita nitrogen generation rate | IPCC 2006 |

# SUB-SECTOR SPECIFIC ASPECTS: WASTE SECTOR
# 4D1 – DOMESTIC WASTEWATER TREATMENT & DISCHARGE

# Sector Specific aspects- Waste Sector

## Domestic Wastewater Treatment & Discharge – Overview




- *Domestic Wastewater treatment* produced 3 561 Gg $CO_2e$
- This is 80 % of total Wastewater Treatment & Discharge emissions
- Emissions from *Domestic wastewater treatment* increased by 42.6% between 2000 – 2020

# Sector Specific aspects- Waste Sector

## Domestic Wastewater Treatment & Discharge– Factors Used

| Type of treatment or discharge | Maximum $CH_4$ producing capacity (BOD) | $CH_4$ correction factor for each treatment system | Emission factor |
|---|---|---|---|
| | (kg $CH_4$/kg BOD) | (MCF) | (kg $CH_4$/kg BOD) |
| Septic system | 0.6 | 0.5 | 0.30 |
| Latrine – rural | 0.6 | 0.1 | 0.06 |
| Latrine – urban low income | 0.6 | 0.5 | 0.30 |
| Stagnant sewer (open and warm) | 0.6 | 0.5 | 0.30 |
| Flowing sewer | 0.6 | 0.0 | 0.00 |
| Other | 0.6 | 0.1 | 0.06 |
| None | 0.6 | 0.0 | 0.00 |

# Sector Specific aspects- Waste Sector

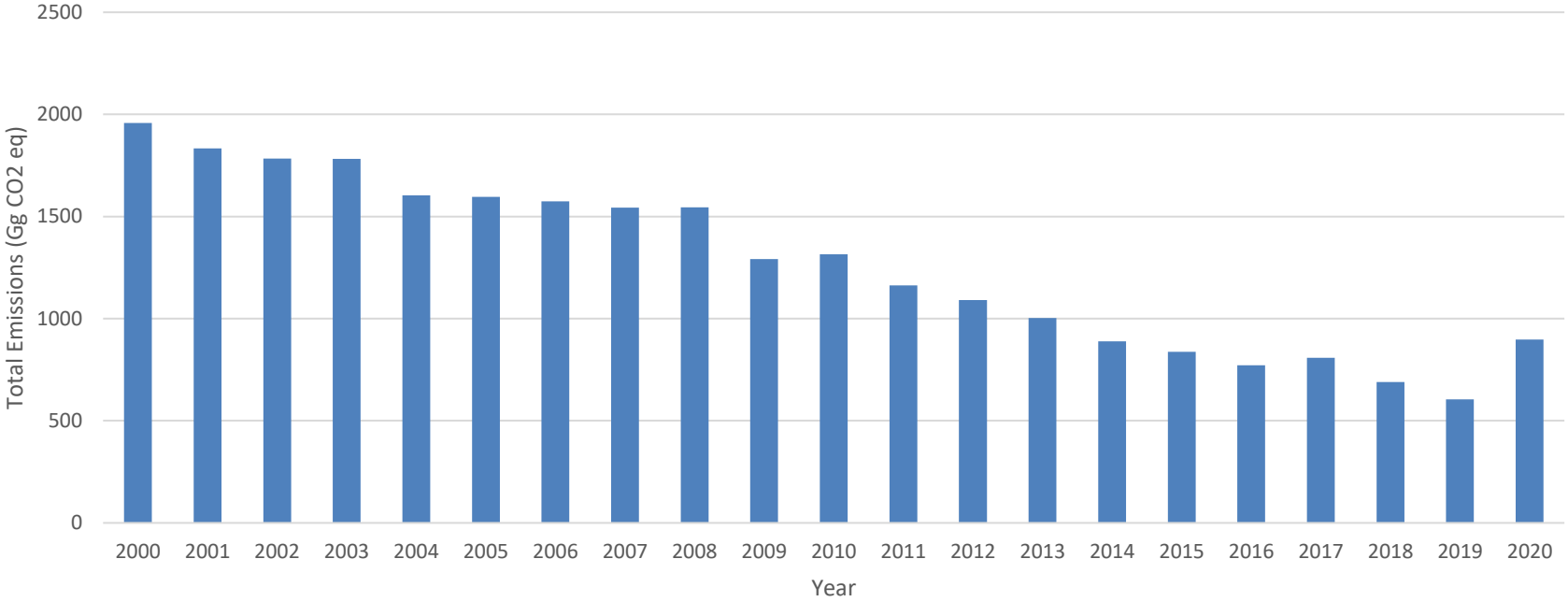
## Domestic Wastewater Treatment & Discharge– Factors Used

| Income group | Fraction of population income group | Type of treatment or discharge pathway | Degree of utilization |
|---|---|---|---|
| | | (kg $CH_4$/kg BOD) | (Tij) |
| Rural | 0.39 | Septic tank | 0.10 |
| | | Latrine – rural | 0.28 |
| | | Sewer stagnant | 0.10 |
| | | Other | 0.04 |
| | | None | 0.48 |
| Urban high-income | 0.12 | Sewer closed | 0.70 |
| | | Septic tank | 0.15 |
| | | Other | 0.15 |
| Urban low-income | 0.49 | Latrine – urban low income | 0.24 |
| | | Septic tank | 0.17 |
| | | Sewer (open and warm) | 0.34 |
| | | Sewer (flowing) | 0.20 |
| | | Other | 0.05 |

# SUB-SECTOR SPECIFIC ASPECTS: WASTE SECTOR
# 4D2 – INDUSTRIAL WASTEWATER TREATMENT & DISCHARGE

# Sector Specific aspects- Waste Sector

## Industrial Wastewater Treatment & Discharge – Overview




- Emissions from industrial wastewater treatment and discharge were 897 Gg $CO_2e$ in 2020.
- $CH_4$ from industrial wastewater treatment in 2020 are 54.2% lower than the level of 2000.
- The trend in emissions in this source category is highly dependent on changes in output in various sectors of industry.

# Sector Specific aspects- Waste Sector

## Industrial Wastewater Treatment & Discharge – Context & Key Assumptions

- Emissions of methane from wastewater and their sludge generated in treatment systems were taken into account.
- A waste improvement study implemented in the year 2019, collected actual AD for the period 2000-2017 for all the sectors of wastewater and biological solid waste, as well as a forecasting model for 2018-2035 for industrial wastewater.
- The input AD were quantities of production per sector for the period; wastewater generated per production tonne; COD concentration in wastewater for the period 2000 – 2017 this activity data was then extrapolated to cover the entire time series.
- $CH_4$ recovery was not considered due to lack of information on projects for the collection and utilization of methane in facilities for the treatment of industrial wastewater.

## Domestic Wastewater Treatment & Discharge – Planned Improvements

- Continue collecting more detailed data on the applied technologies of wastewater treatment in various industries via the mandatory GHG reporting regime.
- Continue on the analysis and assessment of the data reported through mandatory GHG reporting regime to enhance the accuracy of the emissions from this category.

# THANK YOU!

**Climate Change Monitoring Evaluation and Mitigation**
**GHG Inventory & Systems**

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