5.A - Biological Treatment of Waste: Solid Waste Disposal on Land

Short description

Category Code	Method		AD	EF
5.A	T1		NS	D

	NO$_x$	NMVOC	SO$_2$	NH$_3$	PM$_{2.5}$	PM$_{10}$	TSP	BC	CO	Pb	Cd	Hg	Diox	PAH	HCB
Key Category:	-	-/-	-	-	-/-	-/-	-/-	-	-	-	-	-	-	-	-

T = key source by Trend **L** = key source by Level

Methods	
D	Default
T1	Tier 1 / Simple Methodology *
T2	Tier 2*
T3	Tier 3 / Detailed Methodology *
C	CORINAIR
CS	Country Specific
M	Model

* as described in the EMEP/EEA Emission Inventory Guidebook - 2019, in the group specific chapters.

AD - Data Source for Activity Data	
NS	National Statistics
RS	Regional Statistics
IS	International Statistics
PS	Plant Specific data
As	Associations, business organisations
Q	specific Questionnaires (or surveys)
M	Model / Modelled
C	Confidential

EF - Emission Factors	
D	Default (EMEP Guidebook)
C	Confidential
CS	Country Specific
PS	Plant Specific data
M	Model / Modelled

In category **5.A**, NMVOC and PM$_{2.5}$ emissions from managed disposal in landfills are reported in accordance with review recommendation DE-5A-2017-0001. In addition to that, for the sake of completeness, PM$_{10}$ and TSP emissions were also reported.

In the period since 1990 (and previously, to some extent), a number of legal provisions have been issued pertaining to Germany's waste-management sector, and a number of relevant measures have been initiated. These moves have had a strong impact on trends in emissions from waste-landfilling. Relevant developments have included intensified collection of biodegradable waste from households and the commercial sector, intensified collection of other recyclable materials, such as glass, paper/cardboard, metals and plastics; separate collection of packaging and recycling of packaging. In addition, incineration of settlement waste has been expanded, and mechanical biological treatment of residual waste has been introduced. As a result, the amounts of landfilled settlement waste decreased very sharply from 1990 to 2006, and stabilised at a low level since 2006. Today over half of settlement waste produced in Germany is collected separately and gleaned for recyclable materials (separate collection of recyclable materials and biodegradable waste). National statistical data are used (see sub-chapter "activity- data").

In 2004, about 2000 landfills of relevance for this category were in operation in the Federal Republic of Germany.
In June 2005, in keeping with new, stricter requirements under the Ordinance on Environmentally Compatible Storage of Waste from Human Settlements (Abfallablagerungsverordnung) and the Landfill Ordinance (Deponieverordnung), nearly half

of those landfills were closed. As a result, in 2017 less than 1100 landfills, divided into 5 deposition classes are still in operation.

Also, pursuant to regulations in force since June 2005, landfilling of biodegradable waste is no longer permitted - for conformance with pertinent requirements, settlement waste and other biodegradable waste must be pre-treated via thermal or mechanical-biological processes. All these measures have had strong impact on the formation of NMVOC, $PM_{2.5}$, PM_{10} and TSP so that their emissions decreased significantly since 1990.

Methodology

For the estimation of NMVOC, Germany decided against the proposed EF of the EMEP/EEA Guidebook 2019, but instead for the Tier 1 approach of the US-EPA which is also reproduced there (Part B, 5.A, chap. 3.2.2, p. 5; [1]). According to national experts in the field, the approach of the US-EPA is more likely to produce better data, because the ratio between NMVOC (1.3 %) and CH_4 (98.7 %) in VOC from landfill gas is scientifically sound and assumed to be the very same in Germany. Also, already existing and published data for methane emissions from landfills, derived from the IPCC-FOD Waste Model (see NIR of Germany), can be used. However, with the NIR 2023 some of the emission parameters used to estimate methane emissions have been modified (DOC for food waste, DOCf for wood/straw, half-life time for paper and wood/straw) according to the results of research projects initiated for the improvement of the German inventory reporting (Stegmann et al, 2018; S. 172-173, Table 36 [2]). As a result, the Methane emissions have changed considerably and thus the related NMVOC-emissions that are reported here.

Emissions for $PM_{2.5}$, PM_{10} and TSP, reported under this category, are calculated using the Tier 1 approach of the EMEP/EEA Guidebook 2019, where the emission factors are 0.033 [g/t], 0.219 [g/t] and 0.463 [g/t] (Part B, 5.A, chap. 3.2.2, Table 3-1, p. 5; [3]). The EFs are multiplied with the total amount of solid waste (AD) treated in managed above-ground landfillings, following the standard equation:

EM = AD * EF

As stated above the AD in use comprise the total amount of solid waste deposited, meaning, that all mineral wastes are also included.

Activity data

Data from 1990 until 2005 are made available for the UBA by the National Statistical Agency by means of a direct data provision (Statistisches Bundesamt, January 2019; [4]). Data for 1991+1992 and 1994+1995 are not available and have been interpolated.

From 2006 until today, Official statistical data (Statistisches Bundesamt, Fachserie 19, Reihe 1: Abfallentsorgung (Waste management), Table 2.1; [5]) are used for the estimation. The data are published on a yearly basis with an exception for the actual year of reporting. The activity data for the actual year of reporting are obtained, initially, by carrying the relevant data from the previous year forward, in unchanged form. In the following year, when the actual activity data for the given year becomes available, they replace the data that were carried forward. With regard to emissions from landfills, this procedure has only a very small impact on the total emissions in the relevant current report year.

Emission factors

See above under Methodology.

Uncertainties

The AD from Statistisches Bundesamt usually have an uncertainty of ±3% whereas the uncertainties for the PMs and TSP emission factors, according to the EMEP/EEA Guidebook (Part B, 5.A, chap. 3.2.2, Table 3-1, p. 5), were estimated to be:

$PM_{2.5}$	-99% / +385%
PM_{10}	-99% / +379%
TSP	-99% / +377%

Due to the fact that for the ratio of NMVOC and CH_4 in VOC from landfill gas no range is given in the EMEP-Guidebook, the overall uncertainty for the emission estimation of NMVOC is estimated by expert judgement to be ± 50%.

Recalculations

Regular back-calculations are required annually for the previous year, since the waste statistics of the Federal Statistical Office are published with a one-year delay for the data on the quantities and compositions of waste deposited, so that the current reporting year must therefore be estimated. The estimate is replaced in the following year with the then current data.

Since the recalculation required as a result is very small overall in each year, it will not be reported additionally here.

However, in this year's reporting the need for correction of PM and TSP is higher than usual and thus a recalculation is reported (see following table).

Table: Revised PM + TSP-emissions [t]

		2020
PM 2.5	IIR 2023	1,3628
	IIR 2022	1,4398
PM 10	IIR 2023	9,0442
	IIR 2022	9,5553
TSP	IIR 2023	19,1209
	IIR 2022	20,2013

Additionally, as already stated above, in this year's reporting, some of the emission parameters for the estimation of methane emissions from solid waste disposal have been modified (see respective chapter of the NIR 2023), leading to a considerable change. Due to the fact that the method for the estimation of NMVOC emissions is directly linked to the CH4 amounts estimated by using the IPCCs FOD-Model, the NMVOC-emissions are also affected and recalculated as shown in the following table:

Table: Revised NMVOC-emissions [kt]

	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020
IIR 2023	17,495	17,808	12,358	7,696	4,241	2,442	2,191	2,015	1,856	1,612	1,399
IIR 2022	18,018	18,868	13,904	10,042	6,642	4,707	4,409	4,186	3,979	3,786	3,567

> For **pollutant-specific information on recalculated emission estimates for Base Year and 2019**, please see the recalculation tables following chapter 8.1 - Recalculations.

Planned improvements

Currently no improvements are planned.

[1,3] EMEP/EEA, 2019: EMEP/EEA air pollutant emission inventory guidebook 2019, Copenhagen, 2019

[2] Stegmann et al, 2018, Überprüfung der methodischen Grundlagen zur Bestimmung der Methanbildung in Deponien, Hamburg/Stuttgart

[4] Statistisches Bundesamt, Data provision by Mail, 14.01.2019; Data are confidential; Wiesbaden

[5] Statistisches Bundesamt, Fachserie FS 19, Reihe 1: Abfallentsorgung; Wiesbaden; URL: https://www.destatis.de/DE/Publikationen/Thematisch/UmweltstatistischeErhebungen/Abfallwirtschaft/Abfallentsorgung.html