

3.I - Agricultural: Other

Short description

NFR-Code	Name of Category	Method	AD	EF	State of reporting										
3.I	Agriculture other														
consisting of / including source categories															
3.I	Storage of digestate from energy crops	T2 (NH ₃ , NO _x)	Q, PS	CS (NH ₃ , NO _x)											
	NO _x	NM VOC	SO ₂	NH ₃	PM _{2.5}	PM ₁₀	TSP	BC	CO	Pb	Cd	Hg	Diox	PAH	HCB
Key Category:	-/-	-	-	-/-	-	-	-	-	-	-	-	-	-	-	-
Method(s) applied															
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 category chapters.															
(source for) Activity Data															
NS		National Statistics													
RS		Regional Statistics													
IS		International Statistics													
PS		Plant Specific													
As		Associations, business organisations													
Q		specific Questionnaires (or surveys)													
M		Model / Modelled													
C		Confidential													
(source for) Emission Factors															
D		Default (EMEP Guidebook)													
CS		Country Specific													
PS		Plant Specific													
M		Model / Modelled													
C		Confidential													

Country specifics

In 2021, NH₃ emissions from category 3.I (agriculture other) derived up to 0.7 % from total agricultural emissions, which is equal to ~ 3.2 kt NH₃. NO_x emissions from category 3.I contribute 0.16 % (~ 0.17 kt) to the total agricultural emissions. All these emissions originate from the storage of digestate from energy crops (for details on anaerobic digestion of energy crops see Rösemann et al. 2023, Chapter 5.1 ¹⁾). The emissions resulting from the application of energy crop digestates as organic fertilizer are dealt with under 3.D.a.2.c.

Activity Data

Time series of activity data have been provided by KTBL (Kuratorium für Technik und Bauwesen in der Landwirtschaft / Association for Technology and Structures in Agriculture). From these data the amount of N in energy crops fed into anaerobic digestion was calculated.

Table 1: N amount in energy crops fed into anaerobic digestion

N amount in energy crops in Gg N

1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
0.1	0.7	5.6	47.6	172.0	214.5	234.9	284.1	297.3	308.8	307.1	302.1	297.6	297.8	304.2	304.2

Table 2: Distribution of gastight storage and storage in open tank of energy crop digestates

Distribution of gastight storage and non-gastight storage, in %																
	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
gastight	0.0	4.7	9.4	15.8	42.2	47.5	59.4	61.9	63.9	64.6	64.8	64.5	64.8	65.5	65.8	65.8
non-gastight	100.0	95.3	90.6	84.2	57.8	52.5	40.6	38.1	36.1	35.4	35.2	35.5	35.2	34.5	34.2	34.2

Methodology

The calculation of emissions from storage of digestate from energy crops considers two different types of storage, i.e. gastight storage and open tank. The frequencies of these storage types are also provided by KTBL (see Table 2). There are no emissions of NH₃ and NO from gastight storage of digestate. Hence the total emissions from the storage of digestate are calculated by multiplying the amount of N in the digestate leaving the fermenter with the relative frequency of open tanks and the emission factor for open tank. The amount of N in the digestate leaving the fermenter is identical to the N amount in energy crops fed into anaerobic digestion (see Table 1) because N losses from pre-storage are negligible and there are no N losses from fermenter (see Vos et al. 2022, Chapter 10.2.1.).

Emission factors

As no specific emission factor is known for the storage of digestion residues in open tanks, the NH₃ emission factor for storage of cattle slurry with crust in open tanks was adopted (0.045 kg NH₃ -N per kg TAN). This choice of emission factor is based on the fact that energy crops are, in general, co-fermented with animal manures (i. e. mostly slurry) and that a natural crust forms on the liquid digestates due to the relatively high dry matter content of the energy crops. The TAN content after the digestion process is 0.56 kg TAN per kg N. The NO emission factor for storage of digestion residues in open tanks was set to 0.0005 kg NO-N per kg N. Table 3 shows the resulting implied emission factors for NH₃ -N and NO-N. NO_x emissions are related to NO-N emissions by the ratio of 46/14. This relationship also holds for NO-N and NO_x emission factors.

Table 3: IEF for NH₃ -N and NO-N emissions from storage of digested energy crops

1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
IEF in kg NH₃-N per kg N in digested energy crops														
0.0252	0.0240	0.0228	0.0212	0.0146	0.0132	0.0102	0.0096	0.0091	0.0089	0.0089	0.0089	0.0089	0.0087	0.0087
IEF in kg NO-N per kg N in digested energy crops														
0.00050	0.00048	0.00045	0.00042	0.00029	0.00026	0.00020	0.00019	0.00018	0.00018	0.00018	0.00018	0.00018	0.00017	0.00017

Trend discussion for Key Sources

NH₃ and NO_x from storage of anaerobically digested energy crops are no key source.

Recalculations

All time series of the emission inventory have completely been recalculated since 1990. Table REC-1 shows the effects of recalculations on NH₃ and NO_x emissions from storage of anaerobically digested energy crops. Differences to last year's submission occur only in 2019 and are due to the update of activity data (see main page of the agricultural sector, [Chapter 5 - NFR 3 - Agriculture \(OVERVIEW\)](#), **recalculation reason No 16**). For further details on recalculations see Vos et al. (2022), Chapter 3.5.2.

Table REC-1: Comparison of NH₃ and NO_x emissions of the submissions (SUB) 2021 and 2022

NH ₃ / NO _x emissions in Gg																
	SUB	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
NH ₃	2022	0.0015	0.0190	0.1563	1.2267	3.0426	3.4504	2.9206	3.3062	3.2814	3.3428	3.3004	3.2741	3.2013	3.1419	3.1419
NH ₃	2021	0.0015	0.0190	0.1563	1.2267	3.0426	3.4504	2.9206	3.3062	3.2814	3.3428	3.3004	3.2741	3.2013	3.2013	

NO _x	2022	0.0001	0.0010	0.0084	0.0659	0.1634	0.1852	0.1568	0.1775	0.1762	0.1795	0.1772	0.1758	0.1719	0.1687	0.1687
NO _x	2021	0.0001	0.0010	0.0084	0.0659	0.1634	0.1852	0.1568	0.1775	0.1762	0.1795	0.1772	0.1758	0.1719	0.1719	



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

Uncertainty

Details are described in [chapter 1.7](#).

¹⁾

Rösemann C, Vos C, Haenel H-D, Dämmgen U, Döring U, Wulf S, Eurich-Menden B, Freibauer A, Döhler H, Steuer B, Osterburg B, Fuß R (2023) Calculations of gaseous and particulate emissions from German agriculture 1990 – 2021: Report on methods and data (RMD) Submission 2023.

<https://www.thuenen.de/de/fachinstitute/agrarklimaschutz/arbeitsbereiche/emissionsinventare>