3.I - Agricultural: Other

Short description

NFR-Code	Name of Category	Method	AD	EF	Key Category [1]	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 key category	

Legend T = key source by Trend / L = key source by Level

Methods D: Default RA: Reference Approach 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/CORINAIR 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, surveys

EF - Emission Factors D: Default (EMEP Guidebook) C: Confidential CS: Country Specific PS: Plant Specific data

Country specifics

In 2019, NH_3 emissions from category 3.I (agriculture other) derived up to 0.6 % from total agricultural emissions, which is equal to ~ 3.2 kt NH_3 . NO_x emissions from category 3.I contribute 0.15 % (~ 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. 2021, Chapter 10 [1)]. Note that these emissions of NH_3 and NO_x from storage of anaerobically digested energy crops are excluded from emission accounting by adjustment as they are not considered in the NEC and Gothenburg commitments (see adjustments). 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**
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	297.6

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**
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	64.8
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	35.2

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. There are no emissions of NH_3 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 Rösemann et al. 2021, Chapter 10.2.1. Emission factors As no specific emission factor is known for the storage of digestion residues in open tanks, the NH_3 emission factor for storage of cattle slurry with crust in open tanks was adopted (0.045 kg NH_3 -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 NH_3 -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 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**
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	64.8
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	35.2

Table 3: IEF for NH_3 -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
IEF in kg NH_3-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	0.0089
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	0.00018

Trend discussion for Key Sources

NH_3 and NO_x from storage of anaerobically digested energy crops are no key source.

Recalculations

Table 3 shows the effects of recalculations on NH_3 and NO_x emissions. Differences to the last year's submission are due to the update of activity data (**recalculation No 12**, see main page of the agricultural sector (https://iir-de-2020.wikidot.com/3-agriculture). Further details about recalculations are described in Rösemann et al. (2021), Chapter 3.5.2.

Table 4: Comparison of NH_3 and NO_x emissions of the submissions (SUB) 2020 and 2021

NH_3 / NO_x emissions in Gg															
	SUB	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
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
NH_3	2020	0.0015	0.0190	0.1563	1.2267	3.0426	3.4504	2.9206	3.3062	3.2814	3.3428	3.3004	3.2741	3.2895	
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
NO_x	2020	0.0001	0.0010	0.0084	0.0659	0.1634	0.1852	0.1568	0.1775	0.1762	0.1795	0.1772	0.1758	0.1766	

Uncertainty

Details will be described in chapter 1.7.

[1]
Rösemann et al. (2021): Rösemann C., Haenel H-D., Vos C., Dämmgen U., Döring U., Wulf S., Eurich-Menden B., Freibauer A.,

Döhler H., Schreiner C., Osterburg B. & Fuß, R. (2021): Calculations of gaseous and particulate emissions from German Agriculture 1990 –2019. Report on methods and data (RMD), Submission 2021. Thünen Report (in preparation). https://www.thuenen.de/de/ak/arbeitsbereiche/emissionsinventare/