

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) | | | | | | | | | | | |
| Key Category | SO ₂ | NO _x | NH ₃ | NMVOC | CO | BC | Pb | Hg | Cd | Diox | PAH | HCB | TSP | PM ₁₀ | PM _{2.5} |
| 3.I | - | -/- | -/- | - | - | - | - | - | - | - | - | - | - | - | - |

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 |

Country specifics

In 2020, NH₃ emissions from category 3.I (agriculture other) derived up to 0.6 % from total agricultural emissions, which is equal to ~ 3.1 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 Vos et al. 2022, Chapter 10 ¹⁾). Note that these emissions of NH₃ 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 [Adjustment DE - D - Nitrogen oxides \(3.D.a.2.c Other organic fertilisers applied to soils \(including compost'\)\) & Ammonia from Energy Crops](#)). 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 (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 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 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 |
|---|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| 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 | 0.0089 |
| 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

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 2018 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 15**). For further details on recalculations see Rösemann et al. (2021), Chapter 3.5.2.

Table REC-1: Comparison of NH₃ and NO_x emissions of the submissions (SUB) 2020 and 2021

| NH₃ / 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⁾

Vos et al. (2022): Vos C., Rösemann C., Haenel H-D., Dämmgen U., Döring U., Wulf S., Eurich-Menden B., Freibauer A., Döhler H., Schreiner C., Osterburg B. & Fuß, R. (2022): Calculations of gaseous and particulate emissions from German Agriculture 1990 –2020. Report on methods and data (RMD), Submission 2022. (in preparation).

<https://www.thuenen.de/de/ak/arbeitsbereiche/emissionsinventare/>