

Considerations for ammonia relevant to future review of the Gothenburg Protocol.

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Summary

1. The purpose of this note is to summarize available documentation relevant for the on-going review of the Gothenburg Protocol, in accordance with Article 10.4 of the amended protocol: “The Parties shall, no later than at the second session of the Executive Body after entry into force of the amendment contained in decision 2012/2, evaluate ammonia control measures and consider the need to revise annex IX.”

Background

2. The Gothenburg Protocol includes several elements that relate to ammonia (NH₃):
 - a. **Objective to control and reduce emissions of ammonia** (Article 2.1).
 - b. **Objectives to reduce and as far as possible avoid exceedance of critical loads for acidification and eutrophication from nitrogen deposition and of concentrations of particulate matter**, since control of ammonia emissions contribute to reducing environmental and health impacts associated with these concerns (Article 2.1 (a), (b), (d)).
 - c. **Objective to reduce and as far as possible avoid exceedance of the critical level for ammonia** under the amended Gothenburg Protocol (Article 2.1(e); Annex I, para V), as described in the Convention’s Manual on Methodologies and Criteria for Modelling and Mapping Critical Loads and Levels and Air Pollution Effects, Risks and Trends.
 - d. **Emissions ceilings for 2010** as compared with emission levels for 1990, as set out in Annex II of the original Gothenburg Protocol of 1999,
 - e. **Emissions ceilings for 2010 to 2020**, as set out in Annex II (Table 1) of the Gothenburg Protocol as amended in 2012,
 - f. **Emission reduction commitments for 2020 and beyond**, as compared with emission levels in 2005, as set out in Annex II (Table 4) of the Gothenburg Protocol as amended,
 - g. **Annex IX** on measures for the control of emissions of ammonia from agricultural sources. This annex describes measures that are to a varying extent mandatory for Parties in the geographical area of EMEP, as noted in Article 3 (paras. 8 and 10). The annex was not changed when amending the protocol in 2012; it therefore reflects the state-of-the art of the mid-1990s.
 - h. **Guidance Document on preventing and abating ammonia emissions from agricultural sources**, originally Guidance Document V (decision 1999/1) as referred

¹ Prepared with the assistance of the International Nitrogen Management System (INMS).

in Annex IX of the Gothenburg Protocol, which has since been revised as ECE/EB.AIR.120, adopted in 2012.²

- i. **Application of Best Available Techniques**, as referred in Article 3.8(b) of the amended Gothenburg Protocol and as listed in guidance adopted by the Executive Body. The adopted BAT guidance in line with Article 3.8(b) applies to all significant sources of ammonia, while the referrals to this same guidance in Annex IX (see point h. above) are specific for manure application, manure storage and animal housing.
 - j. **Framework (advisory) code of good agricultural practice for reducing ammonia emissions**, EB.AIR_WG.5_2001_7, which was prepared to support Parties in implementing the requirement of paragraph 3 of Annex IX to the Gothenburg Protocol to establish their own advisory codes, hereafter referred to as National Ammonia Codes (NACs). The framework code was revised in 2015.³
 - k. **Developing and maintaining inventories and projections for emissions of, among others, ammonia emissions, and their reporting**, as referred in Article 3.11 ter and article 7.1(b) of the amended Gothenburg Protocol. Applying the tier-2 approach as described in the Emission Inventory Guidebook as a minimum.
 - l. **Reporting of nitrogen budgets, nitrogen use efficiency and nitrogen surpluses** and their improvements within the geographical area of EMEP, using guidance adopted by the Executive Body (amended protocol Article 7, para 3d), with the **Guidance Document on national nitrogen budgets**, adopted at the 31st Session of the Executive Body in 2012 (ECE/EB.AIR/119).
3. Key underpinning evidence relevant to the control of ammonia emissions in the context of the nitrogen cycle is available in the following documentation:⁴
- a. **Atmospheric Ammonia**: Detecting emission changes and environmental impacts. Results of an Expert Workshop under the Convention on Long-range Transboundary Air Pollution (eds. Sutton et al., 2009, Springer). Includes agreed updated values for the ammonia critical level, with analysis of trends, hot-spots and regional patterns.
 - b. **The European Nitrogen Assessment**: Sources, effects and policy perspectives (eds. Sutton et al., 2011, Cambridge University Press). Includes spatial analysis of threats, damage costs and examination of solutions.⁵
 - c. **Nitrogen deposition, critical loads and biodiversity** (eds. Sutton et al., 2014, Springer).
 - d. **Costs of Ammonia Abatement and the Climate Co-Benefits** (eds. Reis et al., 2015, Springer). Demonstrates the cost-effectiveness of ammonia abatement.
 - e. **Nitrogen on the Table**: The influence of food choices on nitrogen emissions and the European environment. (European Nitrogen Assessment Special Report on Nitrogen and Food.) (Westhoek et al., 2015, CEH).
 - f. **Towards Cleaner Air**: Scientific assessment report (eds. Maas & Grennfelt, 2016, UNECE).
 - g. **Just Enough Nitrogen**: Perspectives on how to get there for regions with too much and too little nitrogen (eds. Sutton et al., 2020, Springer).
4. Relevant strategy documents of the Convention include:

² The document is published for wider dissemination as “Options for Ammonia Mitigation: Guidance from the UNECE Task Force on Reactive Nitrogen” (eds. Bittman et al., 2014, CEH). http://www.clrtap-tfrn.org/sites/clrtap-tfrn.org/files/documents/AGD_final_file.pdf

³ https://www.unece.org/fileadmin/DAM/env/lrtap/Publications/Ammonia_SR136_28-4_HR.pdf

⁴ Limited copies of selected documents available from tfrn@ceh.ac.uk

⁵ <http://www.nine-esf.org/node/360/ENA-Book.html>

- a. Policy response to the 2016 scientific assessment of the Convention ([ECE/EB.AIR/WG.5/2017/3](#)) and Corrigendum ([Corr.1](#))
 - b. Long-term strategy for the Convention on Long-range Transboundary Air Pollution for 2020–2030 and beyond. Decision 2018/5 ([ECE/EB.AIR/142/Add.2](#))
 - c. Preparations for the review of the Protocol to Abate Acidification, Eutrophication and Ground-level Ozone as amended in 2012 ([ECE/EB.AIR/2020/3-ECE/EB.AIR/WG.5/2020/3](#))
5. New documents submitted to the 58th Session of the Working Group on Strategies and review related to ammonia include:
- a. **Ammonia Assessment Report**, submitted by the chairs of the Task Force on Integrated Assessment Modelling.
 - b. **Draft Guidance Document on Integrated Sustainable Nitrogen Management** ECE/EB.AIR/2020/6-ECE/EB.AIR/WG.5/2020/5, submitted by the chairs of the Task Force on Reactive Nitrogen. (Together with draft revised guidance and a note on amendments).

Specific considerations relevant to ammonia control measures and Annex IX.

6. The following points are noted in considering the Article 10.4 requirement to evaluate ammonia control measures and consider the need to evaluate Annex IX:
- a. It is recalled that Annex IX was not updated in the amended Gothenburg Protocol of 2012. Although many options were discussed (see footnote 12), it was not possible for the parties to agree on an amended text (hence the inclusion of Article 10.4).
 - b. The confidence in measures to control ammonia emissions has increased greatly since these were first discussed by the Convention in the 1990s. Early uncertainty has been largely replaced with a wide recognition that measures for ammonia abatement are available, cost effective and reliable.
 - c. Control of ammonia emissions is now seen as part of a wider strategy to reduce the huge amount of valuable reactive nitrogen resource that is wasted. Activities linked to the International Nitrogen Management System (INMS) have drawn attention to a global loss of reactive nitrogen worth US\$200 billion per year, pointing to the opportunity to “halve nitrogen waste” by 2030, saving US\$100 billion per year globally⁶, as embraced as part of national action plans under the Colombo Declaration⁷. Air Convention parties are also addressing these issues nationally/regionally, as illustrated for example by the recent Farm-to-Fork and Biodiversity Strategies of the European Commission (there expressed as a goal to reduce nutrient pollution by 50% by 2030).⁸
 - d. The long-term strategy 2030 for the Convention puts a strong focus on the need to reduce further ammonia emissions and on the importance of integrated nitrogen management.
 - e. Since the adoption of Annex IX, new knowledge on the wider N-cycle has shown the importance of win-win opportunities for ammonia emissions reduction by

⁶ UNEP Frontiers Report: The Nitrogen Fix: <https://apo.org.au/sites/default/files/resource-files/2019-03/apo-nid224376.pdf>

⁷ Colombo Declaration on Sustainable Nitrogen Management: <https://papersmart.unon.org/resolution/sustainable-nitrogen-management>

⁸ EU Farm-to-Fork Strategy: https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal/actions-being-taken-eu/farm-fork_en

addressing in an integrated manner with nitrogen oxides.⁹ Although NO_x emissions from soils are currently excluded from the Gothenburg Protocol as amended (Annex II, Table 3), with ongoing reductions in NO_x emissions from combustion, soil NO_x may account for up to 25% of total emissions for some parties by 2030. This highlights the need for coordinated reduction of NH₃ and NO_x emissions from agricultural soils, especially, since this could facilitate simultaneous reduction of nitrous oxide (N₂O) emissions, di-nitrogen (N₂) emissions, and nitrate (NO₃⁻) and other reactive nitrogen leaching within the context of more efficient management of the nitrogen cycle.

7. Several Parties of the Convention have made further progress in commitments to reduce ammonia emissions, including in the revised National Emissions Reduction Commitments Directive of the European Union (Directive (EU) 2016/2284)¹⁰, which describes both emission reduction commitments for years between 2020-2030 and after 2030, relative to 2005 (Annex II, Table B) and a set of specific measures for ammonia emission reduction (Annex III, part 2).¹¹
8. A wide range of policies and measures is now being implemented by Parties to achieve their national emissions reduction commitments for ammonia. These include: measures on animal housing, storage of manure, spreading of solid and liquid manures and of urea and other inorganic fertilizers to land, together with measures to promote recovery and re-use of nitrogen and other resources, with an emphasis on reducing pollution and developing the circular economy with innovation opportunities.
9. It should be recognized that progress has been slow in establishing National Ammonia Codes, as required by Annex IX, paragraph 3. Although the original protocol entered into force in 2005, first analysis by the Task Force on Reactive Nitrogen in 2010 (ECE/EB.AIR/WG.5/2010/13, paragraph 33) found that very few parties had established clearly identified National Ammonia Codes. Subsequent review has seen the number slowly increasing, but overall, many Parties appear to have largely neglected this requirement of the protocol.

Way forward

10. Annex IX to the Gothenburg Protocol reflects the state-of-the-art of the mid-1990s. Since then, knowledge regarding ammonia emissions and its link to/role in the overall integrated nitrogen management has developed and there is greatly increased experience and confidence in measures to reduce ammonia emissions. Therefore, the review of the Gothenburg Protocol provides a timely opportunity to revise Annex IX and develop other actions on ammonia.
11. The review process should take note of the cost-effectiveness of ammonia control as compared with further NO_x abatement from combustion sources, and of the opportunity to improve nitrogen use efficiency and profitability across the UNECE region, with multiple wins. Given the substantial financial waste from nitrogen losses globally (US\$ 200 billion per year), in addition to even larger environment, health and climate costs, reducing ammonia

⁹ Sutton M.A. et al. (2017) The European Nitrogen Assessment 6 years after: What was the outcome and what are the future research challenges? In: *Innovative Solutions for Sustainable Management of Nitrogen*. (Eds.: Dalgaard T. et al.). pp 40-49. Aarhus University and the dNmark Research Alliance.

<https://sustainablesoilsalliance.squarespace.com/s/The-European-Nitrogen-Assessment-Prof-Mark-Sutton-003.pdf>

¹⁰ https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv%3AOJ.L_.2016.344.01.0001.01.ENG

¹¹ Such a technical annex on ammonia to some extent mirroring Annex IX of the Gothenburg Protocol was not included in the original National Emissions Ceilings Directive of 2001.

emission as part of a global goal to halve nitrogen waste can be seen as a key opportunity for innovation as part of post-COVID economic recovery.

12. Review of possible measures for ammonia should take note of the many documents previously considered by the Working Group on Strategies and Review concerning options for the revision of Annex IX.¹²

¹² The Working Group may wish to note the following documents related to revision of Annex IX:

- ECE/EB.AIR/WG.5/2008/10 (Paragraphs 31-32).
- ECE/EB.AIR/WG.5/2009/12 (Annex: Report on work in progress on Annex IX).
- **ECE/EB.AIR/WG.5/2010/4** (Paragraphs 5-74, including High (A), Middle (B) and Low (C) ambition options, plus Annex I: Information on possible farm-size thresholds in relation to mandatory measures for land application of manures.
- **ECE/EB.AIR/WG.5/2010/5** Options for revising the Gothenburg Protocol. Draft Revised Technical Annex IX (bracketed options for revision of the protocol) (Note prepared by TFRN co-chairs).
- **ECE/EB.AIR/WG.5/2010/13** (Paragraphs 9-16, 33 and Annex: Explanation of amendments to the options for revision of the Gothenburg Protocol, Annex IX).
- **ECE/EB.AIR/WG.5/2010/14** Draft revised Annex IX.
- WGSR-47th Session, Informal Document 2. Draft revised technical Annex IX – with annotation and explanation.
- **ECE/EB.AIR/WG.5/2011/3**: Draft revised Annex IX – updated annotated draft and clean copy including revised options A, B, C.
- **ECE/EB.AIR/WG.5/2011/13**: (Paragraphs 23-32 on explanation of draft Annex IX).
- **ECE/EB.AIR/WG.5/106**: Report of WGSR-49 (Paragraphs 35-38).
- ECE/EB.AIR/2012/11: Draft revised Annex IX. The proposed text was not supported by TFRN.
- ECE/EB.AIR/WG.5/2012/3: (Paragraph 9).