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Working Group on Strategies and Review

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Item 2 of the provisional agenda

Progress in the implementation of the 2024–2025 workplan

Report of the Task Force on Reactive Nitrogen

Summary

At its twenty-fifth session (Geneva, 10–13 December 2007), the Executive Body for the Convention on Long-range Transboundary Air Pollution established the Task Force on Reactive Nitrogen (TFRN). In accordance with its revised mandate set out in the annex to decision 2018/6, the Task Force is required to report on progress in its work to the Working Group on Strategies and Review.

The present report of the Task Force presents an overview of activities of the Task Force covered by its mandate and summarizes the progress in the implementation of the 2024–2025 workplan for the implementation of the Convention (ECE/EB.AIR/154/Add.1, forthcoming).

The 18th meeting of the Task Force will take place on 18–19 June 2024 in Aarhus, Denmark (hybrid format), as follow-up to the 17th meeting of the Task Force taking place in Dessau (hybrid format) on 2–4 May 2023, and the special meeting with focus on the Ammonia Guidance Document Revision process, hosted 16–17 November 2023 at Aarhus University, Denmark. The main focus for the TFRN work in 2023–2024 was on this ammonia guidance document revision, and the interactions with impacts on other emissions, including methane, and the related effects on biodiversity, climate etc., including effects from changes in the whole food system. This work involves collaboration with other key bodies and task forces, and the current workplan progress reported, and upcoming meetings organized.

I. Introduction

1. The present report summarizes the progress of the Task Force on Reactive Nitrogen in implementing the 2024–2025 workplan for the implementation of the Convention (ECE/EB.AIR.154/Add.1, forthcoming) and provides an overview of activities covered by the mandate of the Task Force (decision 2018/6, annex).

During the period after the last reporting for the WGSR-61 meeting in September 2023, the activities in the TFRN expert panels have continued, including status meetings and the activities reported below. Co-chaired by Mr Tommy Dalgaard (Denmark), Ms Claudia dos Santos (Portugal) and Mr Mark Sutton (United Kingdom), the 18th meeting of the Task Force will take place at Aarhus University on 18-19 June 2024 (hybrid format, sponsored by Denmark), back-to-back with the XXII International N-workshop. On 16-17 November 2023 a TFRN workshop took place in Aarhus, Denmark (hybrid format) focusing on the revision of the UNECE Ammonia Guidance Document. The meeting was attended by 51 participants from 20 countries and international organisations and kindly hosted by the Land-CRAFT.dk Center for Landscape Research in Sustainable Agricultural Futures.

II. Overview of activities of the Task Force covered by its mandate

2. The work of the Task Force is implemented by the following expert panels, and reports of ongoing activities, including those reported at the TFRN special meeting 16-17 November 2023 (see Annexes for full report):

- (a) Expert Panel on Mitigation of Agricultural Nitrogen (EPMAN);
- (b) Expert Panel on Nitrogen Budgets (EPNB);
- (c) Expert Panel on Nitrogen and Food (EPNF);
- (d) Expert Panel on Nitrogen in countries of Eastern Europe, the Caucasus and Central Asia (EPN-EECCA).

3. The major part of the TFRN work in 2023-2024 was programmed in relation to the UNECE ammonia guidance document revision process (hosted by EPMAN), including the interactions with impacts on other emissions, e.g. methane, and the related effects on biodiversity, climate etc., the effects on Nitrogen Budgets (by EPNB) and effects from changes to the whole food system, including drivers from changes in dietary patterns, food production systems and chains (by EPNF). The synthesised work is promoted broadly, including a special focus on benefits for EECCA countries, e.g. in form of national level good agricultural practice promotion to abate nitrogen emissions (a special workshop with Georgia is planned), and the sponsored involvement in the planned XXIII Nitrogen Workshop and TFRN-18 meeting in June 2024. This work involves collaboration with other key bodies and task forces as reported in Section III below, in coordination with meetings organized.

4. The Co-Chairs of **Expert Panel on Mitigation of Agricultural Nitrogen** (Mr Shabtai Bittman and Ms Barbara Amon) brought forward the process of updating the present Ammonia Guidance Document (which was last revised in 2012), as agreed by the Working Group on Strategies and Review (WGSR). Until now, 38 international experts have volunteered to contribute to the revision of this document. An expert group work meeting was held at the University of Aarhus on 16th and 17th Nov 2023 with Alberto Sanz-Cobena and Rasmus Einarsson coordinating the process together with the EPMAN co-chairs. Chapter leads were identified who introduced the status of their chapter, suggested needs for update and are now working together with their respective teams of authors (see annexes to this document). A follow up workshop is planned for June 2024. The TFRN co-chairs are in discussion regarding possible sponsorship of a further workshop (first quarter of 2025) with stakeholders to review as a basis for completing revision of the Ammonia Guidance Document.

5. The co-chairs of the **Expert Panel on Nitrogen Budgets** (Mr Wilfried Winiwarter and Mr Markus Geupel) collected feedback from users of the “Guidance Document on National Nitrogen Budgets”. Feedback received have been updated on the Task Force webpage¹ – and recommend all users to check the material and report back to the panel co-chairs.
6. The main task of the Expert Panel on Nitrogen Budgets (EPNB) in the 2024 Workplan is the Revision of the UNECE Guidance Document on National Nitrogen Budgets and its technical annexes. To fulfil this task, EPNB is closely engaged in a project (funded by the German Federal Environment Agency) to streamline and update the annexes to the existing UNECE Guidance Document. The aim is to finalize the revision by February 2025 as a basis to report to TFRN and WGSR. That would allow adoption by the Executive Body (December 2025) and consideration to include the revised Guidance document on Nitrogen Budgets in as part of proposed revision of the Gothenburg Protocol.
7. At the same time, also a data submission sheet for Nitrogen Budgets is being elaborated within this project. This will help the Task Force to prepare and evaluate a call for data on National Nitrogen Budgets to the National Focal Points, due in 2025, i.e. the second half of the Workplan. The reporting template will be compatible with a visualization tool that has been developed in the framework of the GEF/UNEP project ‘Towards the establishment of an International Nitrogen Management System’ (INMS) by the UK Centre for Ecology & Hydrology, Edinburgh. Experienced Expert Panel members perform or consult this project targeting for finalization at an upcoming EPNB meeting in Dessau (Germany), 5 and 6 November 2024. The state of work will be shared with the TFRN at the next TFRN-18 meeting in June 2024, in Aarhus, Denmark.
8. The co-chairs of the **Expert Panel on Nitrogen and Food** (Mr Adrian Leip, Ms Susanna Kugelberg and Mr Joao Leite) provided an update on the Second Special Report of the European Nitrogen Assessment (on nitrogen and food) entitled “*Appetite for Change: food options for nitrogen, environment and health*”. The new report was published during December 2023.² They highlighted the conclusion that a target to reduce nitrogen pollution by 50% is extremely difficult to meet without changing to a more plant-based diet. Their model analysis showed that a combined scenario integrating technical measures in agriculture, dietary change and food-waste reduction estimated to provide the most acceptable approach to achieve such ambitious goals, as now linked to both the EU Farm to Fork Strategy and the Kunming-Montreal Global Biodiversity Framework.
9. The co-chairs of the Expert Panel proposed a workshop with policy makers for 2024 that could discuss the Appetite for Change report, considering the relative role of technical and non-technical measures, including opportunities from different dietary mixes (Mediterranean diet, organic food etc.). The Task Force agreed to support the option of a thematic session at a future meeting of WGSR, and to provide input in the findings with the Task Force on Integrated Assessment Modelling.
10. The discussion noted that earlier results from the Expert Panel³ showed that halving meat and dairy intake in the European part of the region (‘demitarian scenario’) would reduce ammonia emissions by around 40 per cent, with co-benefits for health and climate. It was agreed that dietary change has a significant potential to influence nitrogen losses to the environment, including ammonia, nitrous oxide, nitrogen oxides, nitrate and di-nitrogen. The new *Appetite for Change* report shows how, in the European part of the UNECE region, meat and dairy consumption is excess of dietary needs, and is contributing substantially to pollution and waste of nitrogen resources.

¹ Expert Panel on Nitrogen Budgets webpage: <https://www.clrtap-tfrn.org/epnb>

² *Appetite for Change: food options for nitrogen, environment and health*. <https://www.clrtap-tfrn.org/content/appetite-change-food-system-options-nitrogen-environment-health-2nd-european-nitrogen>

³ Westhoek *et al.* (2015) *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.). Edinburgh, UK: Centre for Ecology & Hydrology. Available at: http://www.clrtap-tfrn.org/sites/clrtap-tfrn.org/files/documents/EPNF_Documents/Nitrogen_on_the_Table_Report_WEB.pdf

Mobilization Activities

11. It is noted that the **XXII International N Workshop Conference**⁴ will be hosted at Aarhus University on 16-21 June 2024, and will be used as an opportunity to further advance the TFRN Expert Panel activities, and development of guidance documents.

12. The International Nitrogen Assessment represents a global scale follow-up to the European Nitrogen Assessment (published in 2011), which has been prepared with the support of the GEF/UNEP sponsored INMS project. The assessment is due for publication in 2025 by Cambridge University Press.

13. The Task Force has also contributed to the objectives of the Convention, to the further follow up of the **UNEA Resolutions 4/14, 5/2 and the Colombo Declaration**⁵ including by:

(a) Developing a perspective on measures to “halve nitrogen waste” defined as the sum of all reactive nitrogen losses, including denitrification to di-nitrogen, which is equally a waste of resources,⁶ as part of mobilizing action in the “Nitrogen Decade” up to 2030, including exploring technical options for calculating and expressing total nitrogen waste. With the emergence of Green Ammonia as a future fuel, it is noted that burning of NH₃ to N₂ is not a form of nitrogen waste (as it fulfils its purpose), but that associated emissions of NH₃, NO_x and N₂O to the environment would constitute forms of nitrogen waste.

(b) It is noted by the Task Force that the Kunming-Montreal Global Biodiversity Framework (GBF) Target 7, to at least halve pollution from excess nutrients, represents a major new step in mobilizing actions to halve nitrogen waste. The Task Force emphasized that future activities related to possible revision of the Gothenburg Protocol be seen in the light of this agreement, and that the major challenge ahead was in mobilizing the update of measures that would help achieve this target. Whereas the GBF is focused on biodiversity benefits, the Task Force noted that meeting Target 7 would simultaneously give major benefit for reducing health and ecosystem effects of air pollution.

(c) Contributing to a global analysis of the health costs of nitrogen pollution published in the journal *Science*, which showed that, overall, measures to mitigate pollution by fine particulate matter by abating ammonia emissions are estimated as 10 times more cost-effective than further control of nitrogen oxides emissions.⁷

(d) Contributing to a global analysis of the effectiveness of nitrogen mitigation options for cropland, published in the journal *Nature*, which showed that 11 key measures could reduce nitrogen losses from croplands to air and water by 30–70%, while increasing crop yield and nitrogen use efficiency (NUE) by 10–30% and 10–80%, respectively.⁸

Expert Presentations

14. Further expert presentations contributed substantially to the TFRN 16-17 November 2023 Meeting (Annex 1,2 to this document) included:

- (a) Ammonia emission trends and current status. Framework of the revision process (Mr. Mark Sutton; UKCEH, INMS)
- (b) Nitrogen management taking into account the whole nitrogen cycle & N/C interactions (Mr. Rasmus Einarsson, Swedish University of Agricultural Sciences; Mr. Alberto Sanz-Cobena; AgrosceNa-Lab/CEIGRAM-UPM, Land-CRAFT)

⁴ <https://conferences.au.dk/nworkshop>

⁵ Colombo Declaration on Sustainable Nitrogen Management, available at

https://web.archive.org/web/20221201000000*/https://apps1.unep.org/resolution/?q=node/286

⁶ The Nitrogen Decade: mobilizing global action on nitrogen to 2030 and beyond”, *One Earth* 4, 10-14, available at: <https://doi.org/10.1016/j.oneear.2020.12.016>.

⁷ Gu *et al.* (2021) Abating ammonia is more cost-effective than nitrogen oxides for mitigating PM_{2.5} air pollution. *Science* **374** (6568) 758-762. <https://www.science.org/doi/10.1126/science.abf8623>

⁸ Gu *et al.* (2023) Cost-effective mitigation of nitrogen pollution from global croplands. *Nature* **613**, 77–84 <https://www.nature.com/articles/s41586-022-05481-8>

- (c) Livestock housing & feeding strategies (Mr. Anders Peter S. Adamsen, Mr. Peter Kai & Mr. Martin Weisbjerg; Aarhus University & Nadège Eduard, INRAE)
- (d) Manure management (manure processing, additives and AD) (Ms. Laurence Loyon, INRAE & Mr. Sebastian Wulf, KTBL)
- (e) Measures on synthetic fertilizers (Mr. Andreas Pacholski; Von Thuenen Institute; Mr. Nicholas Hutchings, Aarhus University)
- (f) Manure application techniques (Ms. Johanna Pedersen, Aarhus University & Mr. Wajid Umar; ATB Potsdam)
- (g) Methods for measurements & Quality criteria (Mr. Jesper Nørlem Kamp; Aarhus University; Ms. Mélynda Hassouna, INRAE).

15. A special note was made about Efficiency versus Effectiveness, where Mr. Nick Hutchings noted that “Efficiency is a metric that measures the response resulting from a defined input e.g. the efficiency of slurry injection for NH₃ emissions is the NH₃-N emitted per unit mass of slurry N applied. We would usually normalise this by expressing the efficiency relative to broadcast application as the reference used in the Ammonia Guidance Document.

Effectiveness is the extent to which a measure is capable of achieving a desired objective. This normally includes the efficiency of the measure but will also take into account other aspects. For example, slurry injection is an efficient method for reducing NH₃ emissions but since it cannot be used on very stoney soils or steep slopes, it may not be applicable everywhere that slurry needs to be applied, so the effectiveness of the measure will be reduced if such conditions are relevant. Inevitably, there is some variation in the use of the words between people and between disciplines. For example, an economist might state that investing in a slurry injector has a low efficiency (measured as the reduction in NH₃ emission per € invested), if much of the area where it would be used is too stoney or steep”.

III. Progress in the implementation of the 2024–2025 workplan for the Convention

16. The list of workplan items in the 2024–2025 workplan include ongoing activities, which was continued from 2023, for e.g. the revision of the Ammonia Guidance Document, and a list of new activities which is mainly just started or will take place in the following reporting period.

17. The relevant items from the 2024–2025 workplan are noted below, together with a brief comment on the current status.

Workplan Item	Activity description/ objective	Expected outcome/ deliverable	Lead body(ies)	Resource requirements and/or funding source	Status as of April 2024
2.1.3	Provide technical support on options to inform preparations for possible future updating of annex IX to Gothenburg Protocol	Extent dependent on availability of additional resources and according to guidance from WGSR	TFRN	Subject to availability of resources	Awaiting steer from WGSR
2.1.6	Continued cooperation with and monitoring of the work withing INMS on the International	Identifying and highlighting report recommendations relevant for Air Convention, and identification of most effective nitrogen measures.	TFRN	Subject to availability of resources	Work is ongoing to complete the International Nitrogen Assessment for submission to

	Nitrogen Assessment, including preparation of specific summary for Convention's policymakers	Summary of Air Convention relevant messages shared with WGSR			publishers during 2024.
2.1.7	Analyse implications of NH ₃ as energy carrier as part of decarbonization strategies, including possible emissions of NH ₃ , N ₂ O and NO _x , and possible interactions with international N market prices	Information note submitted to WGSR	TFRN in cooperation with TFIAM and TFTEI	Subject to availability of resources	Work has commenced in forming a core group, with initial messages summarized in Annex 4 of the present report.
2.1.8	Examination of benefits and barriers to dietary change to reduce N air pollution, including co-benefits, possible scenarios and opportunities to overcome barriers	(a) Information document on benefits, including co-benefits, and barriers of dietary change, possible scenarios and opportunities to overcome barriers (b) Information document on opportunities for bioeconomy technologies and measures (c) Thematic session as part of WGSR session on use of non-technical (dietary) measures to reduce NH ₃ and other pollutants emissions.	TFRN in cooperation with TFIAM TFRN TFRN	Subject to availability of resources Subject to availability of resources	The "Appetite for Change" report has been published in December 2023 (for URL see footnote 2). Cooperation with TFIAM is ensuring that appropriate inputs and discussion happens during the next TFIAM meeting.
2.1.9	Assessment of opportunities for mobilizing N recovery and reuse (white ammonia and white nitrogen) leading to extension of an existing database	Short information document	TFRN	Scale of effort subject to additional resources	INMS is completing a database on nitrogen measures including aspects related to White Ammonia and White Nitrogen. The database and accompanying INMS Guidance Document are due for publication during 2024. Once available a summary note will be prepared with WGSR.
2.1.10	Assessment of risks associated with "alkaline air" and analysis of policy implications	Short information document	TFRN in cooperation with WGE	Scale of effort subject to additional resources	To be provided during 2025.

2.1.11	Assessment of technical and non-technical options for meeting Global Biodiversity Framework target 7, with special reference to N air pollution, including benefits of such action	Short information document	TFRN in cooperation with WGE	Scale of effort subject to additional resources	To be provided during 2025
2.2.1	Promotion of guidance documents, including those recently adopted	Explore opportunities to promote guidance documents, including those recently adopted within and beyond ECE region	TFRN, TFIAM, TFTEI, TFICAP		The UNECE Guidance Document on Integrated Sustainable Nitrogen Management is now published with a colour document and being widely disseminated. ⁹
2.2.3	Development of guidance document on non-technical and structural measures	Draft guidance document submitted to Executive Body for adoption	TFIAM, TFRN, TFTEI		Information from the Appetite for Change report will be used to support TFIAM in this task with input from EPNF.
2.2.4	Scoping of possible integrated N framework code (linking different forms of N including interactions with other gases)	Information document prepared to support discussion by WGSR in 2024 on possible merits of such a framework code in relation to needs of different audiences and relationship to other framework codes	TFRN	Subject to funding	Awaits further steer from WGSR in relation to the process to revise the Gothenburg Protocol.
2.2.5	Revision and publication of Guidance document on national nitrogen budgets and supporting documents	(a) Revised Guidance document on national nitrogen budgets submitted for consideration to WGSR and Executive Body in 2025 (b) Extended summary for policymakers based on revised Guidance document (c) Policy brief based on revised Guidance document and extended summary for policymakers to engage with parallel activities (d) Call for data to Parties in 2025, encouraging them to make use of reporting template on national nitrogen	TFRN	In-kind contributions by Germany Subject to funding	a) Funding has been obtained and work is in progress with a view to publication during 2025 (see paragraphs 9 to 10 bis. of the present report). b) and c) to be completed during 2025 d) The call for data is scheduled for 2025.

⁹ <https://unece.org/environment-policy/publications/guidance-document-integrated-sustainable-nitrogen-management>

		budgets with analysis of results in 2025–2026			
2.2.6	Continue revision of Guidance document for preventing and abating ammonia emissions from agricultural sources	Revised Guidance document ready for submission to WGSR in 2025–2026 (depending on availability of resources)	TFRN	Subject to co-funding from Parties for stakeholder workshops	The process has commenced with a workshop in November 2023 and a workshop scheduled for June 2024. (see paragraph 6 of the present report). Funding is being sought for a workshop with stakeholders (first quarter 2025) as a basis to finalize the revision.
2.2.7	Review ECE Framework Code For Good Agricultural Practice for Reducing Ammonia Emissions and commence revision based on conclusion of revised Guidance document for preventing and abating ammonia emissions from agricultural sources	Revised document submitted in 2026–2027	TFRN	Subject to availability of funding	Scheduled to start in 2025.
2.2.8	Further elaboration on interactions between emissions of CH ₄ and NH ₃ , and other N compounds, and potential for their co-mitigation from agricultural sources	Guidance document and policy brief developments	TFRN in cooperation with TFTEI and other bodies	€50,000, subject to availability of co-funding	Awaiting guidance from WGSR.
4.4.2	Workshop to promote good agricultural practice at national level (e.g. Georgia or another interested country) to assist countries in abating nitrogen emissions and managing nitrogen more sustainably that help maintain ecosystems and build capacity to adapt to climate change	Raised awareness of national beneficiaries (farmers) on national advisory codes and climate co-benefits of good agricultural practice	Secretariat, in cooperation with TFRN	Total: \$56 500 ^b	It is understood that the UNECE has obtained funding and potential experts are now being sought to support the process.

Annex 1.

Report from the TFRN 1st meeting to work on the revision of the UNECE Guidance Document on ammonia abatement. Aarhus University, Denmark. 16-17 November 2023.

Organizers:

Mr. Alberto Sanz-Cobeña (Spain), Mr. Rasmus Einarsson (Sweden), Ms. Barbara Amon (Germany) and Mr Shabtai Bittman (Canada).

With the support from Land-CRAFT.dk Centre for Landscape Research in Sustainable Agricultural Futures

Programme

Day 1: Thursday 16 November 2023	
9:00-9:15	Welcome (Mr. Klaus Butterbach-Bahl ; Land-CRAFT) Brief introduction to the Land-CRAFT project
9:15-10:10	Ammonia emission trend and current status. Framework of the revision process (Mr Mark Sutton; UKCEH, INMS) <ul style="list-style-type: none"> • See below for an extended summary. • Noted that TFRN now has a UNECE mandate to update the NH₃ GD • Summarized new cost estimations on damages through N pollution (we can consider including a paragraph to the introduction of the GD on the “costs of inaction”) • Showed information on global increase on N waste including international policy agreements (From an article in One Earth: “The Nitrogen Decade”)¹⁰. • Highlighted the differences between Brown Ammonia – fossil fuel NH₃ production; Blue Ammonia (CCC storage as compensation); Green Ammonia – NH₃ production only from renewables (but still the risk of elevated N₂O and NO_x emissions remains) and White Ammonia – produced from NH₃ recovered from existing organic and other residues. • X • Pointed to Key Documents: Options for NH₃ mitigation report revision: 2024 / 2025; framework code for Good Agricultural Practice 2025 / 2026 • Discussed whether images be included into the updated document? (The conclusion is yes: images to be included from the outset.) • Discussion on word count and the revision process. • Emphasized that a Track change version of the Guidance Document needs to be produced • Noted that the Executive Body of the UNECE Air Convention has adopted the NH₃ – CH₄ interaction guidance document. • Noted that it might be that at some point TFRN will need to act fast if the UNECE bodies decide to start working on the Annex IX/ • Noted that Categories 1, 2, 3 should be retained for stability reasons (it is “only” an update) and because we have recently used them in the UNECE Guidance Document in Integrated Sustainable Nitrogen Management.

¹⁰ [https://www.cell.com/one-earth/pdf/S2590-3322\(20\)30662-X.pdf](https://www.cell.com/one-earth/pdf/S2590-3322(20)30662-X.pdf)

	<ul style="list-style-type: none"> • Noted that the Ammonia Guidance Document is purely technical (no political debate in relation to costs; the document does not contain mandatory actions, but is a reference of options available) • Recognized that regional differences should be taken into account in the update process from the very beginning • Clarified how the adoption process will work by WGSR and the Executive Body, informed by prior discussion with stakeholders. • Highlighted the damages caused by N pollution and noted that brief on formation on this could emphasize the motivation to take action. • Emphasized that as an ongoing action TFRN needs to build disseminate the narrative that reduction in NH₃ emissions is good for everyone, because it wastes less of an extremely valuable resource, while contributing to improved environment. • There was a reminder by Mr Sutton that the current GD was intended to support the expected annex reductions- of 30% as specified in Annex IX. Therefore revision of the Guidance Document and Annex IX need to be consistent.
10:10-10:15	Structure of the meeting (Mr Alberto Sanz-Cobeña ; AgrosceNa-Lab/CEIGRAM-UPM, Land-CRAFT)
10:15-10:30	Coffee Break (provided by Land-CRAFT)
10:30-11:40	<p>Nitrogen management taking into account the whole nitrogen cycle & N/C interactions (Mr Rasmus Einarsson, Swedish University of Agricultural Sciences; Mr Alberto Sanz-Cobeña; AgrosceNa-Lab/CEIGRAM-UPM, Land-CRAFT)</p> <ul style="list-style-type: none"> • Presented a talk related to Chapter 3 “Nitrogen management, taking account of the whole nitrogen cycle” • Provided general background information on N flows / N losses • Emphasized that the whole system needs to be tackled (see integrated N management document), to understand the full system mitigation potential incl. tradeoffs/co-benefits and synergies/antagonisms • Provided information on co-mitigation on NH₃ and CH₄ , noting that this has to be added to the chapter (at least as a reference to the recently adopted Guidance Document on methane ammonia interactions.) • Noted that information on system boundaries, indicators, N budget, N surplus, NUE are already described in the existing GD document • Noted the need to consider manure management chain effects: e.g., reduced N emissions from manure storage implies more N available for application, and potentially higher losses in application; and reduced N losses in the chain leads to lower need for input of new N from synthetic fertilizers and/or biological fixation • Noted the need to come up with a practical calculation method on how to calculate such chain effects and to provide guidance on operational method to assess chain effects • Noted the need to suggest a model approach to catch downstream effects? Concluded that no definitive answer possible at the moment, but will be considered further. • Noted the need to check with the existing N-flow model that is currently being used by the Task Force on Emission Inventories and Projections (TFEIP) in the context of the EMEP/EEA emission inventory guidebook (https://www.eea.europa.eu/ds_resolveuid/YIU32V4T8D) • Agreed to produce a short list of the most relevant needs for updating chapter 3 • Noted the need to compare the current chapter with the integrated N document (Sutton et al. (eds.), 2022; Nitrogen Opportunities for Agriculture, Food & Environment. UNECE Guidance Document on Integrated Sustainable Nitrogen Management) and check what is written there (and can be referenced rather than having it in full length in the Ammonia GD) • Suggestion to go through the whole Ammonia GD and have all text related to Nitrogen management in Chapter 3 rather than repeating parts of the text several times in the

	<p>document.</p> <ul style="list-style-type: none"> • Mr Einarsson agreed to prepare a list of points of the outcome and the need for changes in the document as a starting point for remote work on the chapters after the workshop (this procedure will be followed with all chapters) and be reported in a separate informal document to the WGSR-62.
11:40-12:40	<p>Livestock housing & feeding strategies (Mr. Anders Peter S. Adamsen, Mr Peter Kai & Mr. Martin Weisbjerg; Aarhus University & Ms. Nadège Edouard, INRAE)</p> <ul style="list-style-type: none"> • Noted their proposal to split the topic into two chapters, given the different aspects of housing and feeding strategies. • Showed the current (in the NH₃ GD) and potential new mitigation measures for cattle, pigs and poultry in barn and storage • Listed some discussion points for the feeding part • Noted that feeds like synthetic amino acids are not allowed in some countries and everything farmers feed animals orally should be certified. • Recommended to discuss at precision feeding techniques • Highlighted the need to discuss more about degradable vs non-degradable proteins and it is important to find a balance between energy and protein • Noted that lists for housing measures needs to be checked and amended; e.g. measures from the background document prepared by Ms Amon and Mr Umar, and technologies mentioned during the discussion need to be included. • Recommended that more detailed information on housing technologies integrate a link to the BREF document into the NH₃ GD. • Noted the difference between new and existing buildings should be made with regard to the housing technologies • Noted that partial air cleaning could be included in the GD, but it has to explained clearly to avoid any confusion. • Noted that it is important that we do not suggest any technique which goes against the animal welfare and we also have to keep in mind the animal production • Pointed out that the revision should aim to avoid including the name of any company while describing any technique. • Emphasized the importance of including integrated precision feeding strategies into the document • Highlighted the need to add information on the use of by-products as feeds • Noted that reference conditions for feeding (and reduction options) will likely be different in the various countries (possible to integrate others including Mr. Brian Jacobsen into the feeding group) • Noted that grazing mitigation efficiencies need to be revisited and checked (e.g. against new science from the Netherlands and from Switzerland) – listen and note also Mr. Sutton’s remarks) • In discussion, Mr. Sutton noted that we accept only evidence from already published papers; but notes on upcoming papers can be made. He added that: if the term “OneHealth” shall be used in the GD, then a clear definition of this term needs to be added.
12:40-13:40	Lunch Break (at the canteen by each participant)
13:30-14:30	<p>Manure management (manure processing, additives and AD) (Ms. Laurence Loyon, INRAE & Mr. Sebastian Wulf, KTBL)</p> <ul style="list-style-type: none"> • Discussed where manure management starts and ends. They suggested that it needs to be defined, considering the different steps from feeding to manure application in fields. • Reviewed several chapters of the Ammonia GD, mainly Chapter 9 • Presented some new measures/technologies (manure processing, nutrient recovery) • Discussed the emerging role of Plasma technology in response to questions Agreed that plasma technology will also be included with the different aims that it may have

	<p>(e.g. acidification or fertilizer production).</p> <ul style="list-style-type: none"> • Noted that feed additives that are currently listed as UNECE Category 2 or 3, could potentially also be removed from the document (as they were from the sust integrated N management; agreed that this needs further discussion) • Noted that organic residues should be included (e.g. energy crops / waste to be digested in anaerobic digesters or sewage sludge) • Suggested that the manure management chapter focusses on MANURE, while other aspects can go into the chapter on overall N management or into “non-agricultural sources” chapter • Noted that technologies that change manure composition should be summarized in the manure management / treatment chapter (i.e. some technologies from the application chapter will move to the management chapter) • Discussed the potential to have a brief introduction to all the manure chapters to organize the content and summarize those aspects which are common to all the manure-related chapters • Noted that Anaerobic Digestion (NH₃) tends to increase NH₃ emissions if no further action is taken, but as part of a package of actions offers opportunity to reduce emissions. It was therefore recommended, that if this should be included, then the revised text should mention that many farms which have AD do not deal properly with the AD digestate, and that this is needed. This is also addressed in the Guidance Document on Integrated Sustainable Nitrogen Management.
14:30-15:30	<p>Manure storage techniques (Ms. Paria Sefeedpari & Ms. Karin Groenestein, WUR)</p> <ul style="list-style-type: none"> • Provided a presentation on principles of storage emissions and their abatement and on the current status of Chapter 6 • Provide a list of challenges produced (e.g. existing and new stores, storage volume, etc.) • Illustrated the importance of considering a combination of techniques, interactions, integrated approaches • Note the preferred units: considering Total Ammoniacal Nitrogen (TAN) entering the manure store • Noted the importance of Anaerobic Digestion (AD) and separation techniques, and concluded that the chapter leads must look back to the earlier documents

15:30-15:45	Coffee break (provided by Land-CRAFT)
15:45-16:45	<p>Manure application techniques (Ms. Johanna Pedersen, Aarhus University & Mr. Wajid Umar; ATB Postdam)</p> <ul style="list-style-type: none"> • Gave a presentation of the current version of the chapter • Proposed first changes to be made to the chapter • Gave detailed information on what should be changed in the chapter • Discussed about deleting some measures from the document which are no longer relevant. • Discussed how to agree revised % mitigation effects? • Noted that low emission measures must at least achieve 30 % reduction (see Annex IX) • Noted that dilution: 1:1 dilution needed to come to a 30% reduction. • Considered that application timing is a very effective measure; unsure how it can be controlled => find a solution on how to treat it with more confidence in the NH₃ GD • Commented that we need to clearly state (at a prominent place in the Guidance Document) that technologies need to be used properly in order to achieve the desired effects. Questioned whether we need a verifiable reference technique.
17:30-18:30	TFRN Bureau Meeting (co-chairs of the different expert panels only)
19:45-21:45	Group dinner
Day 2: Friday 17 November 2023	
9:00-10:00	<p>Measures on synthetic fertilizers (Mr. Andreas Pacholski; Von Thuenen Institute; Mr. Nicholas Hutchings, Aarhus University)</p> <ul style="list-style-type: none"> • Gave a presentation related to Chapter 8 or the Ammonia Guidance Document (GD) • Provided an overview assessment of effects of fertilizer type, weather, soil, urease inhibitors, application and incorporation • Highlighted new EU regulations (e.g. on coating materials) that have to be considered when updating the chapter • Drew attention to a list of open questions and news tasks at the end of the presentation, including discussion about “bio fertilizers”, “bio stimulants” • In discussion Mr Sutton noted that bio stimulants currently Category 3 and that this should be reviewed. • He suggested to differentiate the various urease inhibitors into different categories depending on the effect that they have shown. • The presenters noted that the urease inhibitor cannot be applied together with some other kinds of fertilizers, because their active ingredient tend to be unstable, and that this should be reported. • Noted that various “helpful” products are on the market: suggestion to add a remark that those products can only be integrated into the Ammonia GD if their effect has been independently proven. • Mr Sutton noted that the Guidance Document should take account of various urease inhibitors and the temperature effect • The discussion noted that continuous update of information can be done by sending information documents to the UNECE and by adding updates to the INMS database managed by Mr. Will Brownlie at UKCEH.
10:00-11:00	<p>Methods for measurements & Quality criteria (Mr. Jesper Nørlem Kamp; Aarhus University; Ms Mélynda Hassouna, INRAE)</p> <ul style="list-style-type: none"> • Reported that this section is proposed as a new chapter (Annex) to the Ammonia Guidance Document (GD) • Noted that the Ammonia GD Annex should be concise and brief to give an overview to

	<p>non-technical people.</p> <ul style="list-style-type: none"> • Noted that the full version of the Ammonia GD should contain this annex. Note that it may include a review of valid methods for collecting ammonia (e.g., wind tunnel, chamber-less methods. Techniques that are only relativist vs those that are good for EF's. duration? Rain? etc). • Noted that auxiliary data are relevant and often make the difference whether it is possible to use the data for emissions modelling and emission factor assessment; they stressed that it is important to have information on required auxiliary data in the annex. • Suggested to add also information on methods to establish N excretion rates • Discussed what should be described in the annex e.g., Measurement approached (e.g. Mass Balance) or protocol or detailed technologies. • Proposed that the Annex should be written in the direction of explaining measurement approaches (and also as background information for non-emission measurement experts) and then relate to background literature (e.g. LivAge book) where the detailed description of measurements technologies can be found • Proposed to integrate a decision tree on how to find the best method to measure emissions for specific situations. This was followed by substantial discussion, e.g. in an ongoing EU project; it was noted that it may be that no agreement on the decision tree can be reached in the time frame of the GD update) • Suggested that the Ammonia GD document gives a range of emission reduction effects and that countries then shall select the value within that range that best reflects the situation in their country. • Mr Sutton noted that care was needed when considering how to deal with ranges to ensure consistency with the approach taken in Annex IX of the Gothenburg Protocol and its possible revision. For example, in relation to Annex IX, it will be likely that a minimum reduction of NH₃ emissions needs to be achieved by technologies => for this purpose, a fixed emission reduction number needs to be given. • The discussion noted that, in relation to inventory preparation, a range of reduction efficiencies may be applicable, but only if accompanied by a clear guidance on how to select the appropriate factor from the range (e.g. by describing the conditions under which and how the mitigation technology shall be applied) • It was noted that a decision tree of techniques could be included • Mr Kamp suggested a review of protocols for measurement of ammonia from agricultural sources be conducted. • A future workshop on “Realistic ammonia flux measurement on small (replicate) plots: necessary and feasible?” was announced by Mr Pacholski (see below for more details).
11:30-12:30	<p>Discussion on the way forward regarding NH₃ GD development Chair. (Ms. Barbara Amon; ATB Potsdam & Mr. Shabtai Bittman; Agriculture and Agri-Food Canada)</p> <ul style="list-style-type: none"> • Proposed the next workshop, with the suggestion to meet in the frame of the Nitrogen Workshop in Aarhus (17th – 24th June 2024) • Noted the investigation of funding for a further workshop with stakeholders once the revised draft was in a mature state (e.g., Spring 2025) • Noted that chapter leads could submit abstracts of their chapter outlines to the Nitrogen Workshop or organize a side event (without sending abstracts for this) • • Encouraged Chapter leads to organize chapter teams and start working on the chapters • Noted that Mr Sanz Cobena will provide information on the current status of suggestions of authors by chapter • Encouraged that the process include online meetings; (see Annex 3 below) • Suggested to engage stakeholders in the process – needs to be decided when and how best this can be done and with which purpose (e.g. talk about practicality of measures, completeness of measures).

12:30-13:00	<p>Concluding remarks closing</p> <p>The discussion included the following remarks:</p> <ul style="list-style-type: none"> • Mr Sutton agreed to liaise with the Executive Body on the procedures about length of the update, including agreement for a shorter official version and an longer unofficial version, both of which would be supplied to WGSR and Executive Body for ultimate adoption. • Mr Sutton confirmed that the Executive Summary should be less then 10000 words (including all text). • Mr Sutton drew attention to the existing Annex IX (current version and last version that we had wanted to updated, but which was rejected) to participants noting that the revision process of the Ammonia Guidance Document needs to take into account consistency with Annex IX. • He suggested that when it came to possible revision of Annex IX it would be important to provide WGSR with a range of possible option for different levels of ambition. <p>Housing / feeding:</p> <ul style="list-style-type: none"> • It was noted that reference systems need to be more clearly defined. • It was noted that transferability of technologies (lab versus full scale) needs to be considered. • The group noted that more expertise on livestock feeding strategies would be welcome, especially for monogastric animals <p>Manure management</p> <ul style="list-style-type: none"> • The group agreed to put the manure management chapter before the storage chapter (not only at the end of the document) • The group agreed to check coherency with the new UNECE Guidance Document on Integrated Sustainable Nitrogen Management <p>Manure storage techniques</p> <ul style="list-style-type: none"> • No additional remarks <p>Manure application techniques</p> <ul style="list-style-type: none"> • It was agreed that coordination with manure management needed (e.g. on the effect of manure management on application emissions) • It was noted that research tends to be geographically centered, but emission factors needed for the whole UNECE <p>Measures on synthetic fertilizers</p> <ul style="list-style-type: none"> • The group agreed that interactions with other chapters on biochar, etc. should be initiated • It was agreed that emissions during the fertilizer production process also need to be included in the Ammonia GD <p>Methods for measurements</p> <ul style="list-style-type: none"> • No additional remarks <p>Nitrogen Management</p> <ul style="list-style-type: none"> • The group agreed to describe precision farming technologies in the document • The need was noted to provide context on focusing on NH₃ in the wider context of many other issues (e.g., N losses other than NH₃, interactions with phosphorus and possibly other nutrients, special considerations for organic agriculture, to name a few) • Discussion considered the need to provide guidance on how to account for chain effects

Annex 2.

Key needs for the UNECE ammonia GD revision (presentation by Mr Mark Sutton, UKCEH)

**Key needs for revision of the
UNECE Ammonia Guidance Document**

Mark Sutton
UK Centre for Ecology & Hydrology

TFRN-EPMAN Workshop,
Aarhus 16-17 Nov 2023

- Mr Sutton gave a wider context for revision of the Ammonia Guidance Document.
- Noted the mandate to the TFRN 2007 related to technical and scientific information provision to be used across UNECE as well as encouraging coordination of air pollution policies on N in the context of the N cycle.
- Highlighted the reporting to the WG on Strategies and Review. Main negotiating body of the Convention. Noted that Parties listen to what TFRN is providing.
- Encouraged the group to think of the Ammonia GD in the wider context of the whole N cycle.
- Highlighted the importance of the nitrogen circular economy. Presented the concept of Nitro-Finance (inc. in the INA, coming soon).
- Noted that the Gothenburg protocol revision could start following the December 2023 meeting of the Executive Body.
- Noted the timeframe of the revision: There is not a fixed date but suggested 2024-2025.
- Emphasized that the process would see first revision of the Ammonia GD then the revision of the Ammonia Framework Code.
- Noted that revision process will be subject to exchanges with the Parties (feedback process).
- Reported the example for the revision of the GD: importance of manure injection and incorporation instead of broadcast. A good example. To be translated to farmers.
- **Encouraged that Images in the revised version of the GD be included.**
- **Drew attention to the UNECE Guidance Document on Integrated Sustainable Nitrogen Management, and that consistency with the Ammonia Guidance Document is important..** Noted that the Integrated GD has less detailed info on ammonia, **while the Ammonia GD is the primary international reference on NH₃ abatement.**
- Drew attention to NH₃-CH₄ interactions: noting that the UNECE Guidance Document on the topic recently been adopted. For the revision of the GD just do cross references with the existing document.
- **Concerning abatement of non-agricultural emissions:** recommended a minimum revision of the existing short chapter and raise awareness pointing out further work in the other sectors.
- **Resources:** a voluntary process with some support. Noted the discussion on funding of a workshop in 2025 with stakeholders. Other funds are welcome.
- **Highlighted the importance of recognizing authorship in the glossy published version of the document which will complement the official UNECE version.**

Task Force on Reactive Nitrogen (TFRN)



UNECE Convention on Long range Transboundary Air Pollution

- Nitrogen and air pollution – toward integrated approach
- Gothenburg Protocol, Annex IX, Ammonia Guidance Doc, Ammonia Framework Code, Guidance Doc N budgets
- Mitigation of Agricultural Nitrogen (EPMAN)
- National Nitrogen budgets (EPNB) & Guidance Doc
- Nitrogen and Food (EPNF), linking envt & health
- Nitrogen in the East (EPN-EECCA), INMS demo region

Ammonia Guidance Document a starting point: What more does policy need?

- Fundamental understanding is critical to inform direction
- A basis to simplify and develop the bigger picture
- Pinpointing the barriers and addressing them
- Listening and addressing what people care about (environment, health, money)
- Being ready to move fast when needed!

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Simple Numbers
Power Narrative
Win-win solutions
Confidence for investment

Annex 3.**Meeting on the revision of the UNECE CLRTAP Ammonia Mitigation Guidance Document.
22.12 2023****Agenda**

Time	Agenda item	Person(s) responsible
5'	Current status of revision process (mandate, scope, length of document)	Alberto Sanz Cobeña Mark Sutton
5'	Any initial questions (Short questions may be answered immediately. Longer questions to be noted and answered at a later stage.)	Alberto Sanz Cobeña (chair) Floor is open
11 × max. 5'	Chapter updates: lead authors, contributing authors, status update (max. 5 minutes per chapter): <ul style="list-style-type: none"> • Chapter 1: Introduction • Chapter 2: Ammonia abatement through a systems approach • Chapter 3: Livestock feeding strategies • Chapter 4: Livestock housing • Chapter 5: Manure treatment (inc. acidification, additives, separation, AD, composting, ...) • Chapter 6: Manure storage • Chapter 7: Manure application • Chapter 8: Synthetic fertilizer application • Chapter 9 (?): Non-agricultural ammonia emissions • Annex A: Methods for measurements & Quality criteria (very important for e.g. additives to manures) of publications (trustable sources of information). • Annex B (?) Ammonia and interactions with (all) GHG (with a focus on methane) 	Alberto Sanz Cobeña (chair) Preliminary chapter leads (see separate Excel file)
10'	Update on relation to revision of Annex IX of the Gothenburg Protocol Update on any other information from the CLRTAP	Mark Sutton
5'	Next steps	Alberto Sanz Cobeña Shabtai Bittman Barbara Amon Rasmus Einarsson
5'	Any final questions or concerns (Short questions may be answered immediately. Longer questions to be noted and answered at a later stage.)	Alberto Sanz Cobeña Rasmus Einarsson (chair) Floor is open

Annex 4.

Progress report on Item 2.1.7 of the workplan for 2024-2025 :

Implications of NH₃ as an energy carrier as part of decarbonization strategies, including possible emissions of NH₃, N₂O and NO_x, and possible interactions with international N market prices

A core team has been formed, under the lead of Mr Rasmus Einarsson, Sweden.

The following progress has been made:

- An initial analysis to quantify main risks for nitrogen pollution due to combustion of ammonia (NH₃) as fuel. Based on a small literature survey and some calculations, we see substantial pollution risks in the form of nitrous oxide (N₂O), nitrogen oxides (NO_x), and ammonia. A large variation in pollution intensity estimates indicates major pollution risks as well as good possibilities for mitigation.
- Initial discussion regarding the Informal document scope and content has been initiated within the TFRN and contact has been established with co-chairs of the TFTEI and the TFIAM. Moreover, several other researchers have agreed to contribute on a voluntary basis to the Informal document.
- A rough outline of the Informal document has been drawn up as follows:
 - NH₃ has a special potential role as a carbon-free energy carrier with fairly high energy density and which could be integrated in both mobile and stationary combustion processes. It is a decarbonisation option worth considering, and there is considerable industry interest.
 - However, there are several serious risks:
 - Unmitigated N₂O emissions could negate a substantial part of the climate benefit compared to fossil fuel.
 - NH₃ is merely an energy carrier which needs to be produced using energy input in some other form. If produced using fossil energy, there will be no net climate benefit of NH₃ fuel.
 - There are non-climate risks related to NH₃ slip and fuel-sourced NO_x emissions from NH₃ combustion.
 - There are possible interactions with N fertilizer markets as NH₃ is currently mainly used as for fertilizer production. Widespread introduction of NH₃ as an energy carrier could outsize fertilizer N flows by an order of magnitude or more, with unknown effects on fertilizer markets, which need further attention from a food security perspective.