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Executive Body for the Convention on Long-range Transboundary Air Pollution

Steering Body to the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe

Working Group on Effects

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Item 5c of the provisional agenda
Progress in activities of the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe and its workplan for 2024–2025: Integrated assessment modelling

Integrated assessment modelling

Report by the Co-Chairs of the Task Force on Integrated Assessment Modelling

Summary

The 53rd session of TFIAM was held 15 - 17 April 2024 in Paris in a hybrid form.

TFIAM discussed the status of the updated GAINS model and concluded that the model is fit to support the Gothenburg Protocol revision with scenario analysis for most of the proposed policy negotiation topics set out in EB decision 2023/05. However, TFIAM and other expert groups require clarification and guidance from the WGSR on details regarding scenarios, data, metrics, target years etc. to be effective in providing input to the revision of the Gothenburg protocol.

TFIAM/CIAM presented the modelling results in updated versions of the Policy Brief (TFIAM53 version, 10 April, and WGSR62 version, 21 April) using current draft scenarios, and presenting corresponding effects on health and environment, as well as first results on the feasibility of reaching a 50% reduction in $PM_{2.5}$ related health effects over the UNECE region and in specific countries, and how this changes with specific parameter settings (base year, static or dynamic demography, calculation of premature mortality or death rates etc.). Modelling also investigated selected staged/phased approaches for the EECCA & West Balkan countries and Türkiye. Current GAINS modelling development focusses on including biodiversity (nature protection) targets into the model, using the new empirical critical loads database from CCE for the whole European UNECE region and for 48 ecosystem classes. The analysis of feasible reductions for health impacts from combined $PM_{2.5}$ and O_3 exposure is planned for 2025. TFIAM also discussed further sensitivity analyses, amongst others the potential impact of extensive use of hydrogen and ammonia as energy carriers and the effect of 'net zero' climate and energy strategies.

Based on scientific consideration, TFIAM/CIAM made suggestions with respect to scenario analysis for the Gothenburg Protocol revisions. TFIAM advised to develop optimized scenarios achieving a certain reduction in risks to human health and ecosystems (exact indicators to be defined) by 2040 compared to a base year 2015. Important optimization targets are (i) a cost-effective reduction of health and ecosystem risks by 50% for the full UN-ECE domain, (ii) country specific targets to reduce health and ecosystem risks by 50% across the UN-ECE domain but based on equal relative efforts by countries to bridge the gap between current policy and maximum feasible reductions, (iii) as above, but with introduction of a limit to the abatement costs as a percentage of GDP as an egalitarian principle , (iv) a socio-economically efficient reduction of health and ecosystem risks in 2040 (CBA-optimal model solution), and (v) flexibility options for current non-parties (staged/phased approaches). Pending further guidance from the WGE, it supports the use of the Average Accumulated Exceedance (AAE) of $CL_{empNmin}$ per ecosystem type, and/or $CL_{empNmean}$ as proxy for ecosystem risks for various ecosystem classes. TFIAM also highlighted the importance for the Air Convention to stay updated with respect to the mortality and morbidity analysis and recommendations expected from the ongoing HRAPIE II and EMAPEC projects led by WHO.

TFIAM also discussed national and international integrated assessment studies. Most likely, large efforts will be needed in several parts of Europe if the WHO air quality guidance values for $PM_{2.5}$ are to be reached. In some regions, they may be difficult to reach. It was reconfirmed that air quality in cities would benefit from local as well as regional emission control, but there is no solution that suits all cities. More research is needed to better understand what city level characteristics drive differences in local level air pollution. There is still a high potential for non-technical measures (behavioural changes and structural changes) to reduce emissions. But implementation of such measures remains a challenge and estimating the related costs and benefits is not obvious. TFIAM recommends more parties to analyse impact of land use changes associated with low GHG emission pathways, air pollution, particularly NH_3-emissions.

The 53rd TFIAM meeting was the first meeting co-chaired by Simone Schucht (France) and Stefan Åström (Sweden). They were assisted by Rob Maas (Netherlands), the former co-chair of TFIAM.

Report of the 53rd session of Task Force on Integrated Assessment Modelling

I. INTRODUCTION

1. This report describes the results of the 53rd session of TFIAM, held in Paris and online from the 15th to the 17th of April 2024. The presentations made during the meeting and the reports presented are available at: http://www.iiasa.ac.at/web/home/research/researchPrograms/air/policy/past_meetings.html.

2. 47 experts participated in Paris, and some 55 online. These represented the following Parties to the Convention: Austria, Belgium, Canada, Croatia, Cyprus, Denmark, the European Union, Finland, France, Germany, Hungary, Ireland, Italy, Malta, the Netherlands, Norway, Poland, Portugal, Spain, Sweden, Switzerland, the United Kingdom of Great Britain and Northern Ireland, and the United States. Other bodies of the Convention represented were Working Group on Strategies and Review (WGSR), Co-operative programme for monitoring and evaluation of the long-range transmission of air pollutants in Europe (EMEP) Steering Body, Working Group on Effects (WGE), EMEP Centre for Integrated Assessment Modelling (CIAM), the Meteorological Synthesizing Centre-West (MSC-West), the Task Force on Techno-Economic Issues (TFTEI), the Task Force on Hemispheric Transport of Air Pollution (TFHTAP), the Task Force on International Cooperation on Air Pollution (TFICAP), and the Task Force on Reactive Nitrogen (TFRN). In addition, a representative from South Korea, the Joint Research Centre of the European Commission (JRC), the Organisation for Economic Co-operation and Development (OECD), and the European Environment Bureau (EEB) were represented.

3. Mr. Stefan Åström (Sweden) and Ms. Simone Schucht (France) chaired the meeting.

4. Mr. Hubert Holin, deputy head of the air quality office of the French ministry in charge of the environment opened the meeting. Mr. Holin highlighted the need to focus on establishing strong and transparent science related to ozone formation and methane emissions.

II. NEWS FROM THE CONVENTION AND OBJECTIVES OF THE MEETING

5. TFIAM noted the presentations by Ms. Schucht and Mr. Stefan Åström on the current development under the Air Convention, the corresponding requests from the Air Convention bodies to TFIAM, on the TFIAM/CIAM workplan and the objectives of the meeting.

6. The 2024-2025 TFIAM work plan contains several activities related to the ongoing revision of the Gothenburg Protocol. All in all, there are some 25 tasks requested of TFIAM. These include work to develop and analyse policy relevant scenarios, and to develop and communicate guidance documents. This includes the production of a policy brief on policy targets. A draft brief has been circulated for comments by national experts. TFIAM are also to support the Air Convention in developing qualitative guidance for the development of scenarios.

7. TFIAM noted the presentation by the Chair of the WGSR on the current requirements for the revision of the Gothenburg Protocol. In May 2024, WGSR will discuss a plan for negotiating the 8 main topics of the revision as explicitly defined in EB decision 2023/5. These include new emission reduction commitments, scope and possible revision of technical annexes, BC emission reductions, methane emissions for pollutants currently covered by the Protocol, further focus on ammonia emission reductions, potential flexibilities to facilitate ratification and implementation by current non-parties, formulating collective risk-based targets including biodiversity loss, as well as development of integrated approaches amongst climate, energy, and air policies.

8. In addition to developing a plan for the overall revision process, the WGSR will initially discuss already at this session on selected issues that are possible to engage in without Parties having established their formal negotiation positions (see Gothenburg Protocol Revision Plan document for details)[1].

9. WGSR hopes that the EB in December 2024 will make decisions inter alia on how the emission reduction targets will be formulated (not which ambition levels and numbers to set), how targets should be set, whether methane should be considered, and to what extent flexibilities should be included.

10. Assuming that the ambition to arrange two WGSR sessions during 2025-2026 is upheld, this should allow EB in December 2025 to discuss draft texts of the revised protocol, and hopefully decide on the topics to be included in the revision. In 2026, the final integrated assessment optimization results should have been made available to enable national positions and decisions.

III. SUPPORT OF FURTHER POLICY DEVELOPMENT UNDER THE CONVENTION

11. TFIAM noted the overview of the policy brief given by the senior TFIAM advisor Mr. Rob Maas. The draft policy brief contains an overview of current state-of-the-art scenarios and corresponding effects on health and environment, as well as first results on the feasibility of reaching a 50% reduction in $PM_{2.5}$ related health effects over the UNECE region and in specific countries, and how this changes with specific parameter settings (base year, static or dynamic demography, calculation of premature mortality or death rates etc.). Whereas reaching a 50% reduction in region-wide PM-health effects appears feasible, the target cannot be met by all Parties. Region-wide targets are also more cost effective than country specific targets. The targets are more difficult to achieve for ozone, partly due to the current global increase in methane emissions offsetting reductions in European precursor emissions. Dietary changes and climate change policies will further facilitate achievement of targets. The current update of the policy brief aims to incorporate replies to comments that Parties submitted by early February 2024. Further comments on the draft policy brief are still welcome.

12. TFIAM noted the presentation given by Mr. Peter Meulepas on the options for new approaches / flexibilities that could be built into the revised Gothenburg Protocol and that aim at facilitating ratification to current non-parties, in particular EECCA, West Balkan countries, and Türkiye. The suggested approaches are grouped as: staged-, phased-, separate section-, sector based-, and individual commitment-based approaches. Comments have indicated that amongst these approaches a sector (source

[1] https://unece.org/sites/default/files/2024-04/ECE_EB.AIR_WG.5_2024_1%20%28E%29.pdf

category) based approach is most aligned with formulations of air pollution legislation, policies, and technical requirements for which experience exists in other regions. There are challenges related to data and local expertise needed when modelling and evaluating scenarios for EECCA, WB, and Türkiye with the GAINS model. Experts from these regions need to be more involved in the data collection as well as scenario and modelling work.

13. TFIAM noted the presentation by Mr. Zbigniew Klimont and Mr. Gregor Kiesewetter on the CIAM support to the Gothenburg Protocol revision and on the latest development of the GAINS model. They presented draft results, as the final scenarios are not yet available.

14. According to the CIAM work plan, there will be a new baseline scenario available to the Convention expert groups by July 2024. The baseline will be based on the EU Clean Air Outlook 4 for the EU and on corresponding scenario work for EECCA, WB, and Türkiye. For non-EU EFTA member states, the baseline scenario will use latest updates from IEA and FAO, as well as initiated bilateral discussions between national experts and CIAM. Furthermore, during spring 2024, the draft baseline scenario is subject to bilateral consultation with EU countries to establish consistency with national projections and scenarios.

15. The current work on analysing staged/phased approaches with the GAINS is based on sector-by-sector abatement strategies, including industry, power plants, as well as road and non-road transport.

16. Scenario analysis of 50% targets exemplifies the need for further qualification from policy makers. For example, if the 50% reduction in health effects from $PM_{2.5}$ is to be achieved in 2040 relative to 2015 emission levels and if population data is kept static at levels for the year 2015, the GAINS model gap closure needed to reach the target is 40% of the gap between CLE and MTFR in 2040. But if demographic change (population growth and aging) between the base and the target year are accounted for, the necessary gap closure increases to 80%.

17. In-depth analysis indicates that emissions from domestic heating will remain a dominant contributor to human health effects, especially for the WB region. Scenarios also indicate that a given target can be reached at lower cost when it is to be attained by the overall region, than when it is to be reached by each Party. Results of first analyses investigating the new flexibilities imagined for current non-parties compare region-wide target setting relative to country-specific target setting, and to sector specific (staged/phased) targets for WB, EECCA and Türkiye. Cost-effectiveness would clearly suffer if these countries would implement current BAT for a selection of sectors, compared to implementing measures chosen in the optimisation with respect to the common target of 50% reduction in health effects.

18. Current GAINS modelling development focusses on including biodiversity (nature protection) targets into the model. This includes the introduction of the new empirical critical loads data base from CCE for the whole European UNECE region and for 48 ecosystem classes. This data base provides two values for each ecosystem class, one for low and one for high ecosystem sensitivity ($CL_{empN\text{-}max}$ vs $CL_{empN\text{-}min}$) of nitrogen. The calculations show ongoing and continuing large exceedances of critical loads when based on $CL_{empN\text{-}min}$, some countries even show increasing damages. But the room for improvement is large with known technical measures, and even more with more

advanced low emission solutions. The possibility to reach a 50% improvement seems feasible in all regions studied with the GAINS model.

19. Some work remains to be done, including cost optimization for targets on reducing biodiversity risks. Other development work includes new estimates of costs and applicability of emission control technologies, modelling of staged approach scenarios for the residential sector, of combined targets for biodiversity risks and $PM_{2.5}$ related health risks. Modelling of ozone effects, analysis of equity issues, as well as analysis of key emission control measures across the region will take place later.

20. TFIAM noted the presentation by Mr. Tim Butler on the current work and development by TFHTAP on the issue of methane impacts on ground level ozone concentrations. In a summary of the five most relevant studies published since 2018 on this issue, the common message is that ground level ozone levels in Europe will increase between 2015-2050 in a baseline scenario, mostly driven by increases in global methane emissions. When studying emission reduction scenarios in 2050, 1/3 of the reduction in ozone levels is due to methane emission reduction (most non-UNECE region), 1/3 due to NOx/NMVOC emission reduction within the UNECE region, and 1/3 due to non-UNECE NOx/NMVOC emission reduction.

21. Future work is expected to include scenario analysis of various ambition levels for NOx, NMVOC, and methane, but because of computational costs, not all policy scenarios can be calculated. However, ensemble modelling is used to develop an ensemble emulator that would allow for rapid assessment of the effects of numerous emission scenarios on ozone concentrations. Prior to starting analysis, TFHTAP requests clarification on the scenarios that are prioritized for the GP revision process, the base year to use, and the year for which to assume that control will take effect.

22. TFIAM noted the presentation given by Mr. Mike Holland on health impact assessment and economic valuation of the impacts. Mr. Holland presented draft conclusions from the EMAPEC project. EMAPEC conclusions indicate that new knowledge allows for inclusion of more morbidity health endpoints when estimating effects on air pollution and health and associated socio-economic costs. Overall, it is likely that the socio-economic costs of pollution will become higher than in earlier Air Convention estimates.

23. TFIAM noted the presentation by Mr. Guus Velders, the co-chair of the Expert Panel on Clean Air in Cities (EPCAC). Mr. Velders presented the current work on developing a position paper clarifying important considerations for management of city air quality. These include possible win-win solutions with climate policies, the importance of transboundary and trans-city transport of pollution, and examples of the importance of local, national, and regional measures to control city air pollution.

24. TFIAM noted the overview of the Air Conventions' newest task force, the Task Force on International cooperation on Air Pollution given by Ms. Anna Engleryd, co-chair. Since inception, the task force has been gathering information about already ongoing capacity sharing efforts by experts within the Air Convention and by other regions and organisations. Ms. Engleryd presented an interesting overview of regional cooperation existing in regions around the world. Common themes relate to air quality monitoring, estimations of impacts of air pollution, and modelling and communicating such results, as well as efforts to establish new legislation.

25. TFIAM noted the overview of recent work by the Coordination Centre for Effects, given by Mr. Markus Geupel. The work of CCE includes monitoring of effects on

acidification, eutrophication etc. But CCE also collaborates with Helcom on marine environment, through the development of the Critical Atmospheric Input (CAI) metric, which allows for risk assessment of atmospheric contribution to marine eutrophication. With respect to the Gothenburg protocol revision, CCE helps with providing indicators of biodiversity loss.

26. During spring 2024, CCE has delivered the new empirical critical loads data base for the whole UNECE region (excl. North America) as well as the receptor maps to CIAM for later analysis of targets with respect to nature protection. These data have been included into the GAINS model, and preliminary results were presented by CIAM during TFIAM 53.

27. TFIAM noted the presentation by Mr. Rob Maas on the process to produce a guidance document on structural and behavioural measures and on results of the draft version of this document. While the application of such measures may allow to reduce health and environmental impacts from air pollution further and at relatively lower costs than technical end-of pipe technologies, their implementation is more difficult, requiring the use of various policy instruments, and their costs and benefits are therefore more difficult to assess. They depend furthermore on specific situations in the countries and results from one implementation example may not apply everywhere across the studied region. TFIAM would be grateful for comments by its members on this document.

28. TFIAM noted the presentation by Mr. Stefan Åström on how to assess potential negative wellbeing effects from implementation of behavioural measures. Theories of behavioural change present several wellbeing-related trade-offs when implementing behavioural measures. However, the current state-of-the-art shows large gaps in data, so the theoretical models can still not be transferred into 'social disbenefits' analogous to technical costs of implementing technical measures.

29. TFIAM noted the presentation by Mr. Adrian Leip and Ms. Susanna Kugelberg on recent results as presented in the report "Appetite for Change: Food system options for nitrogen, environment & health", developed by TFRN. In summary, a target to halve nitrogen waste, as set by international agreements such as the Colombo Declaration (2019), the EU Biodiversity Strategy (2020), or the UN Kunming-Montreal Global Biodiversity Framework (2022, will require behavioural changes in terms of dietary change and food system changes. Maximum technical feasible measures are not sufficient to meet such a target. As a consequence, reduction in both food production and consumption in (large parts) of the UNECE region is needed for reaching this objective. Halving meat and dairy production and consumption is likely to bring highest socioeconomic benefit.

30. Overall, throughout the discussions on support to further policy development, TFIAM noted the request for reiteration of the scientific rational for the policy targets currently assessed by CIAM/TFIAM, as well as the rational for focus on black carbon, ammonia, and methane, as highlighted by Mr. Savolahti.

IV. FURTHER MODEL DEVELOPMENT

31. TFIAM noted the presentation given by Mr. Toon Vandyck from OECD on ongoing work addressing the "triple planetary crisis of climate change, biodiversity, and pollution". An example from a study on global and regional air quality impacts of dietary change (Springmann et al., 2023) shows large positive human health impacts.

Another study on EU energy taxation made to support the Fit for 55 EU climate and energy plan shows some co-benefits between CO_2 emission reduction and $PM_{2.5}$ emission reduction. The co-benefit is stronger for CO_2 and NO_x as the tax changes affect the transport sector. But poverty and inequality are at risk of increasing if no revenue recycling is implemented. But full revenue recycling could enable reduced inequality and emissions at the same time. Currently, work for the OECD Environmental Outlook, includes the setup of a model integration methodology in order to study the "triple crisis".

32. TFIAM noted the presentation by Mr. Enrico Pisoni. JRC has published the new version of the Urban $PM_{2.5}$ Atlas. Key messages from their work include that for many cities, local action on air pollution can have a significant effect on emissions (average 36% for 750 cities), even if the sectors to be targeted for emission reductions are city specific. However, measures to address residential heating and aimed at reducing agricultural emissions would give clear benefits on $PM_{2.5}$ concentrations in cities.

33. Recent developments within the FAIRMODE project include two web-based tools to compare local emission inventories and concentration calculations, respectively with state-of-the-art European emission inventory databases and measured concentrations. The project has also developed an online version of the SHERPA model, to simulate, among other things, the impact of emission reduction scenarios on air quality. FAIRMODE is also starting a work on bias corrections and will report back to TFIAM on this at a later stage.

34. TFIAM noted the presentation given by Ms. Simone Schucht on the latest update of the calculation of marginal damage costs from air pollution for European countries and the quantification of externalities from European industrial facilities for the period 2012-2021. This work takes place within the European Topic Centre on Health and the Environment for the account of the European Environmental Agency. The calculations are updated with respect to source receptor matrices, emission, demographic, health, economic data and new in scientific knowledge. New developments include the calculation of an additional sectoral correction factor accounting for country and sector specific mass fractions of $PM_{2.5}$ in PM_{10}, as well as the fact that marginal damage costs for health effects are made year dependent to better account for demographic change over the period investigated. Compared to earlier editions, a few additional health effects are also taken into account.

35. TFIAM noted the presentation by Mr. Stefan Åström on the 3-year Horizon Europe research project VALESOR that aims at improving economic methods for the valuation of health impacts from air pollutants and chemical substances as well as the use of these methods by decision makers and stakeholders. Ongoing work aims at publishing reviews on the last 10 years of analysis on relevant substances, their health impacts, and economic valuation of the health impacts. The ultimate goal of the project is to develop an online model together with guidance to stakeholders on the use of economic valuation methods for the environmental stressors addressed by VALESOR.

36. TFIAM noted the presentation given Mr. Claudio Belis on trends and sectoral split of anthropogenic CH_4 emissions according to EDGAR v8.0 and recent modelling of CH_4 emission scenario effects on ozone formation, crop yields, and human health using JRC FASST. The modelling confirms that while ozone peaks have shaved off mainly due to the reduction of NOx and NMVOC emissions, baseline ozone levels are increasing. Much caused by the increasing role of increasing global CH_4 emissions.

Furthermore, the modelling shows considerable impacts of CH_4-induced O_3 concentrations on health and crop production in low CH_4-ambition scenarios.

V. PROGRESS OF ASSESSMENT MODELLING BY PARTIES

37. TFIAM noted the presentation of Ms. Helen ApSimon and Mr. Huw Woodward focusing on sensitivities of modelling and scenario choices for future air pollution in the UK. The various new energy technologies currently under discussion, such as hydrogen technologies, can turn out to have large effects on future emissions of NO_x and $PM_{2.5}$, as shown for the United Kingdom scenarios. Net zero scenarios can bring large benefits for air pollution, but this is very dependent on different net zero strategies, for example putting emphasis on energy efficiency and electrification as compared with reliance on CCS. Hence it is important to consider alternative net zero scenarios in optimising air pollution abatement.

38. Analysis of effects on land use changes corresponding to UK net zero strategies shows significant changes in NH_3 emissions following these land use changes. Land use changes that lead to a reduction in animal numbers can deliver NH_3 reductions comparable with what can be achieved by technological measures.

39. TFIAM noted the presentation by Ms. Lilli Kashef Hamadani and Ms. Diane de Kerckhove on the North American Air Quality Agreement. The agreement is covering emission reduction commitments for NO_x, SO_2, as well as targets for ozone levels. The commitment and targets consider regional circumstances. In spring 2024, a review report of the Air Quality Agreement has been published. A review of the agreement has been proposed and will be discussed in 2024.

40. TFIAM noted the presentation by Mr. Guido Lanzani and Mr. Matteo Lazzarini on potential air quality improvements in the Po Valley. Sector emission reduction scenarios indicate that emission reductions of 80% would not be sufficient to reach the air quality standards for $PM_{2.5}$ recommended by WHO. All electric light-weight vehicles, Euro 6 heavy duty vehicles, 5-star Ecodesign standards for local space heaters, NH_3 emission reduction BAT solutions wouldn't be enough to reach such a strong emission reduction. To arrive to a reduction of 80% of all the emissions, it would be necessary to include a drastic change of the behaviour. This change could imply for example a 75% decrease in vehicle mobility, in industrial activities and in the use of natural gas boilers, with a complete ban of the use of wood for domestic heating joint to a reduction of the number of pigs and cattle by 60%.

41. TFIAM noted the presentation given by Mr. Andreas Eisold on possibilities to reduce the $PM_{2.5}$ and NO_2 concentrations in Germany. When forecasting effects on concentrations based on the agreed emission reductions in the NEC Directive several parts of Germany will need to apply additional domestic measures to solve the air quality problem only with domestic measures.

42. TFIAM noted the presentation given by Mr. Mark Barrett on net zero greenhouse gas emission energy scenarios, showing varying energy technology and demand futures and their impacts on the energy system, emissions of greenhouse gases, pollutants, and other chemicals, and on land requirements. Mr. Barrett presented prescriptive scenario solutions including aspiring technologies such as direct air capture and bioenergy CCS. With a focus on aviation and shipping, Mr. Barrett shows the large effects on land and the energy system that could result from a carbon net zero strategy for the UK.

43. TFIAM noted the presentation by Ms. Laura Zecchi who compared air quality scenarios for Italy with two different IAM models, the MAQ model and the SIMBAD model. The comparison showed consistency between the two models, at least for moderate changes from baseline emissions.

44. TFIAM noted the presentation by Ms. Marta García Vivanco on Impacts on air quality of the Spanish National Air Pollution Control Programme and the assessment of individual measures. Emission reductions are still needed for Spain to reach the NEC Directive targets for NMVOC, but there are also several areas where local air quality needs to be improved, especially for ozone. Amongst a set of further measures to reduce emissions, electrification of the transport sector would be most effective to reduce NO_x, whilst improved energy efficiency of buildings would be most effective to reduce PM2.5 emissions. However, increased use of biomass burning in the energy system risks increasing PaH emissions. In addition, the presentation highlighted the uncertainties and limitations when evaluating compliance with air quality in normative scenarios.

V ANY OTHER BUSINESS

45. TFIAM noted the short overview of the current review of the NEC Directive as given by Ms. Panagiota Dilara. Based on the preparation material and the public consultations, the European Commission is expected to finalise a staff working document by the end of 2025 and only then decide whether there is a need for a revision of the NECD.

46. The following deadlines were set for comments from parties participating in TFIAM:

- For the Policy brief on options and scenarios: 1st of July 2024
- For the EPCAC outline for the position paper: 30th of June 2024 (see Appendix 1 to the current report)
- For the NTM guidance brief: 30th of June 2024

47. The date and place for TFIAM54 is yet to be decided.

VI KEY CONCLUSIONS FROM TFIAM AND RECOMMENDATIONS TO WGSR 62

48. TFIAM concludes that TFIAM/CIAM are well setup to support the Gothenburg protocol revision with scenario analysis of most of the 8 proposed policy negotiation topics set out in EB decision 2023/05 for the revision of the Gothenburg protocol.

49. However, TFIAM also concluded that several working groups require clarification and guidance from the WGSR on details regarding scenarios, data, metrics, target years etc. to be effective in providing input to the revision of the Gothenburg protocol.

50. Scientific considerations for scenario analysis by TFIAM/CIAM for the Gothenburg protocol revision would suggest:

- Optimization for the period 2015 to 2040.

  Optimization targets including:

i. a cost-effective reduction of health and ecosystem risks by 50% for the whole domain
ii. country specific targets to reduce health and ecosystem risks by 50% (based on equal efforts by countries to bridge the gap between current policy and maximum feasible reductions),
iii. as above, but with introduction of a limit to the abatement costs as a percentage of GDP as an egalitarian principle,
iv. a socio-economically efficient reduction of health and ecosystem risks in 2040 (CBA-optimal model solution), and
v. flexibility options for current non-parties (staged/phased approaches).

- TFIAM is open for modelling various definitions of "health risks" indicators. Indicator options include Years Of Life Lost (YOLL), Number of premature fatalities, and Number of premature fatalities per total population. TFIAM has no recommendation as to whether health risks should be modelled based on a static (2015) population level, based on a population projection or both. Modelling based on a static population level would directly show the impact of an isolated change in air quality on health.
- The operational model indicator of "Ecosystem risk" can be Average Accumulated Exceedance (AAE) of $CL_{empNmin}$ per ecosystem type, and/or $CL_{empNmean}$. TFIAM appreciates further guidance on the ecosystem risk indicator from the ICP modelling and mapping. Future GAINS model development can enable analysis of other ecosystem risk indicators.

51. The first round of CIAM analysis (summer/autumn 2024) can indicate health risks with $PM_{2.5}$-related health aspects. Later model development will enable health risk analysis indicated by both $PM_{2.5}$ and O_3 exposure.

52. TFIAM highlights the importance for the Air Convention to stay updated with respect to the mortality and morbidity analysis and results that will come from the HRAPIE II and EMAPEC projects.

53. TFIAM discussed further sensitivity analyses. Considered of highest concern were the potential use of hydrogen and ammonia as energy carriers, and also the effect of 'net zero' climate and energy strategies.

54. TFIAM reinforces the recommendation to TFIEP to enhance efforts in establishing air pollution emission factors for hydrogen and ammonia technologies for the energy and transport system.

55. TFIAM concludes that most likely, large efforts will be needed in several parts of Europe if the WHO air quality guidance values for $PM_{2.5}$ are to be reached. In some regions, they may be difficult to reach.

56. TFIAM reconfirmed that air quality in cities would still benefit from local as well as regional emission control, but no solution that suits all cities can be found. More research is needed to better understand what city level characteristics drive differences in local level air pollution.

57. TFIAM concluded that there is still a high potential for non-technical measures / behavioural changes / structural measures to reduce emissions. But implementation of

such measures remains a challenge, and estimating the size of related costs and benefits is not obvious.

58. TFIAM reconfirm that much promise can lie in dietary changes as a measure that reduces both NH_3 and CH_4 emissions, with substantial environmental, climate, and socio-economic co-benefits.

59. TFIAM noted that nitrogen critical load targets are unlikely to be met without dietary changes and recognized that such change will require capacity building in governance structures to integrate technical and non-technical measures.

60. TFIAM recommends more parties to analyse the land use changes associated with low GHG emission pathways, and to what extent such land-use changes would in turn affect air pollution, particularly NH_3.

61. TFIAM notes that more easily accessible web-based assessment tools are and have been developed recently. The existing FAIRMODE air quality tools and the coming VALESOR economic valuation tool, both serve as examples of this progression.

62. TFIAM recommended to make GAINS model baseline scenario country data for the Gothenburg Protocol revision analysis, including scenarios supporting the Clean Air Outlook 4, available to national experts for further scrutiny and to analyse national abatement options.

Appendix 1 – Draft EPCAC Position paper on Clean Air in Cities

Prepared by the UNECE/LRTAP Expert Panel on Clean Air in Cities (EPCAC)

5th draft, April 10, 2024

Preamble

This document contains the table of contents with subjects for the first position paper by the Expert Panel on Clean Air in Cities (EPCAC). According to the work plan in the founding document, EPCAC should "prepare a position paper to raise awareness among national and local policy makers of the multi-scale interactions. To be followed by other relevant guidance documents". The mission of the EPCAC is to analyse and communicate the potential benefits of multi-scale air quality management and find an optimal mix of local, national and international policy actions.
Key questions to be addressed by EPCAC:

- Which actions at which government level are most effective to reduce the negative health impact of air pollution (expressed as loss of life years)?
- Can we say more about the cost-effectiveness of measures at different government levels?
- What knowledge should be improved for robust policy advice? (e.g. on emission data, dispersion modelling, health impact assessment, costs and effects of measures, multi-scale multi objective policy design.)

This first position paper is meant as an introduction into the subject and addressing these key questions. It is based in part on an EPCAC meeting in Bratislava (in 2019) and online meetings (in 2020, 2021, and 2022). The position paper explores possibilities for following guidance documents and further research. In the table of contents, it is indicated what will be discussed in each chapter with preliminary conclusions/messages.

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Summary

1) **Introduction: Air quality is still a problem, especially in cities**
   a) There are significant impacts of air pollution on health and the environment related to exposure to particulate matter ($PM_{2.5}$), nitrogen dioxide (NO_2), and ozone (O_3).
   b) A large part of the urban population in the UNECE is exposed to concentrations that exceed WHO air quality guidelines.
   c) The WHO suggested interim targets for areas with a significant exceedance of the guideline levels. The proposed EU air quality limit values for 2030 are aimed at the most ambitious interim target.
   d) For EU countries to meet the proposed limit values for $PM_{2.5}$ and NO_2 everywhere in 2030 is still a challenge, especially in urban and industrial areas.
   e) For several EECCA and West-Balkan countries this challenge would even be harder.
   f) Combustion is a large local cause of urban air pollution, especially for NO_2, e.g. from industry, traffic, residential heating, with large differences in contributions for different cities. For $PM_{2.5}$ and O_3, sources from further away (regionally/nationally and transboundary) also contribute significantly to air pollution in cities with contributions from ammonia from agriculture.
   g) Air quality is strongly linked with climate change measures; this offers options for win-win solutions but requires careful analyses to prevent adverse effects. Other sustainable development policies, such as green, clean, smart, or circular cities could improve air quality.

Box: City based on administrative boundaries versus population extent

- There are large differences between cities, with large conglomerates of cities closely connected (e.g., Paris), cities in large industrial areas, and cities surrounded mostly by agricultural land.
- Urban health impacts are more related to the reduction of (average) population exposure and less to the number of exceedances of local limit values.
- Measures in the core of large cities might be sufficient to meet the NO_2 limit values but might not significantly reduce exposure in the whole city.
- Cities have administrative boundaries for which local policies can be implemented, but measures in greater city area (or even beyond) will be needed to sufficiently reduce population exposure.
- Multi-layered government actions are needed to reduce population exposure.
- The challenge will be to organize this politically (with some examples, e.g. Berlin, Paris, London, …)

2) The role of cities

a) Cities are an important source of air pollution for surrounding regions.
b) At the same time a large part of urban air pollution comes from sources outside the city itself. This is especially the case for secondary inorganic aerosols (SIA), resulting from ammonia emissions from agriculture and NO_2 and SO_2 emissions from combustion. Also mention organic PM here.
c) The contribution of local measures to improve air quality is limited because air pollution has not only local sources and the jurisdiction of cities is limited. Therefore, collaboration/coordination at the international, national, regional, and city levels is necessary.
d) Multi-level coordination could offer more cost-effective solutions than separate local measures.
e) Positive actions to improve the air quality have been demonstrated for several cities and countries (mention a few examples).
f) Ineffective or counterproductive examples have also been shown (mention a few examples)
g) Coherence with various policy domains, such as, the energy transition, agricultural policy, mobility, and urban planning could offer win-win solutions.

3) Sources of air pollution in cities

The contribution of different sectors and regions to the concentration levels in cities differ among cities. Source apportionment is the first step in designing a cost-effective multi-scale air quality strategy. The JRC-urban PM2.5-atlas and calculations by EMEP/GAINS on the contributions show the relative importance of transboundary, regional, and local sources to urban air quality.

a) Transboundary sources
   - For **particulate matter** concentrations the contribution of transboundary sources can be significant, especially in medium sized cities (less than 1 million inhabitants). An important part of this transboundary contribution are secondary aerosols: mainly aerosol formation in the atmosphere from ammonia and nitrogen oxides, or from ammonia and sulfur oxides). However, also primary PM-emission sources, contribute: wood burning, agricultural waste burning, forest fires, as well large industrial combustion plants (that in some regions are also still an important source of sulfur dioxide emissions).
   - Cities emit large quantities of **nitrogen oxides**, especially during rush hours. Although concentrations decline rapidly with increasing distance from the source, nitrogen oxides still are an important element of transboundary air pollution. Nitrogen oxides contribute to nitrogen deposition on nature areas, to the formation on secondary aerosols (if ammonia is available) or to the formation on ozone.
   - **Ozone** is a typical transboundary pollutant. It is formed in the atmosphere from anthropogenic and biogenic emissions of nitrogen oxides, NMVOCs, and methane, under the influence of sunlight. Primary emission sources can be thousands of kilometres away from the place where high ozone concentrations are experienced. Due to relatively high share of NO close to NOx-emission sources, reduction of NOx-emissions in urbanized areas could lead to higher ozone formation (titration-effect).

Effectively tackling the abovementioned sources requires internationally coordinated actions.

b) National and regional sources

- Potentially important additional national and regional sources of primary particulate matter and nitrogen oxides are highways, airports, large industrial plants, harbour activities, ships, and agriculture (both intensive livestock farming and greenhouse-agriculture). Many of such facilities depend on permits from national or regional authorities. However, they contribute to the urban background concentrations. It illustrates the important role that national and regional governments play in achieving clean air in cities.

c) Local sources

Sources that can be tackled by city governments are:

- **Particulate matter** from residential heating, road traffic, non-road mobile machinery (e.g., construction equipment, ships).
- **Nitrogen oxides** from road traffic, residential heating.

4) Measures

Solutions to improve air quality in cities will be listed (and ranked) in this para. Catalogues of measures exist to help cities (e.g., https://fairmode.jrc.ec.europa.eu/measure-catalogue and annex 8 of the proposed EU Air quality Directive). The question is to what extent local measures will be applicable and sufficient for solving local poor air quality. The main challenges to tackle at city level are transport and domestic combustion. At the national and international level, tackling industrial emissions and ammonia (as a precursor for PM, as well as ozone precursors (NOx, VOC, methane) are important.

a) Examples and experiences of measures taken:
   i) Measures at city level
   ii) Measures at the regional/national level
   In general, the same measures as urban measures, but at a larger scale. The extra measures could be: policies regarding large industries, power plants and waste processing outside the city, plus of course tackling ammonia from agriculture
   What can we learn from GAINS-analyses for cities in Europe and Asia?
   iii) Measures at a transboundary level

b) Ranking of measures. E.g., Ranking Joaquin, 2016).
   i) Measures that reduce emissions in a wider region could result in more health gains than specific local measures or changing the spatial location of sources. Adaptation measures seems to be ineffective (trees and scrubs, catalytic paint, street sweeping).
   ii) The larger the region where measures are taken, the more health gains.
   iii) Most health benefits come from reduction of the average exposure in a region, not from reduction of exposure at a certain hotspot.
   iv) Focusing on (traffic) hotspots could lead to more dispersion of emission sources (e.g. due to changes in traffic circulation and to higher average exposure.

c) Non-technical measures
   i) xyz

5) Conclusion

- Exposure to poor air quality is relatively high in cities with differences between EU and no-EU countries.
- Focus should not only be on hotspots but also on the average exposure.
- The contribution of local sources to the air quality in cities is limited, making regional, national, and international action essential to achieve improvements in air quality.
- Co-benefits from other policy domains could be a key to success, while avoiding detrimental effects.
- Sources of air pollution and most effective measures will differ among cities, but multi-level air quality management remains needed. National Air Pollution Control Programs (NAPCP) could serve as a potential instrument in this.
- Local information on sources in cities in combination with model calculations are needed to assess which sectors are most important for specific cities.

6) Further research needed (the known unknowns) on

a) The combined health impacts of PM, NO2 and ozone
b) The combined impacts of air pollution impacts and heat stress
c) The impact of climate change on concentrations of air pollutants

Annex I

What knowledge is needed to develop a local air quality plan aimed at local health gains?

- emission sources
- air quality measurements
- modelling / source attribution
- inventory of emission abatement measures at various scales
- assessment of costs and health impacts of mitigation measures

Appendix 2: 2024-2025 Workplan items

Decided at the 43rd Executive Body of the Air Convention

WP item	Activities	Outcome	Lead body(ies)	Resources
Scientific activities				
1.1 Improving tools to assess air pollution and its effects in the United Nations Economic Commission for Europe region				
1.1.1 Monitoring and modelling tools				
1.1.1.5	Review source-receptor methodologies: brute force and sensibilities (local fractions) and their applicability	EMEP reports in 2024 and 2025	MSC-W, TFMM, TFIAM, CIAM, TFHTAP	EMEP budget
1.1.1.6	Update GAINS for simulating O_3 response to precursors' emission reductions	Updated GAINS model	CIAM with MSC-W, TFHTAP	EMEP budget
1.1.1.32	Consolidate existing evidence on health outcomes of exposure to air pollution	Report on methods for health risk/impact assessment of air pollution and cost-benefit analysis (update to HRAPIE project)	TF-Health with other groups (TFIAM, TFMM)	Recommended contributions, additional resources required
		Exploratory analysis of recent developments on O_3 and health		Additional resources required
1.1.2 Emission and projection tools				
1.1.2.5	Improve spatial distribution of emissions, assuring consistency across pollutants. Explore new data sources	Updated spatial distribution of emission inventories (2024)	CEIP with IIASA/CIAM	Additional resources required
1.1.3.0	Contribute to Gothenburg Protocol revision as mandated by Executive Body	Pending decision by Executive Body in December 2023	TFIAM, CIAM, TFMM, MSC-W,	EMEP budget and recommended contributions

WP item	Activities	Outcome	Lead body(ies)	Resources
			CCC, TFHTAP, CCE, WGE	
1.1.3.1	Support policy process with scenario analyses, including effect-based approaches and investigating risk-based concept	Calculation and analysis of scenarios	CIAM, MSC-W, TFHTAP, TFIAM, WGE	EMEP budget
1.1.3.2	O_3 modelling of future scenarios	Organize new global model simulations of future scenarios developed by CIAM, including examination of role of CH_4, source attribution methods, link to regional scale and impacts	TFHTAP, TFIAM, CIAM, TFMM, MSC-W, ICP Vegetation	EMEP budget
1.1.3.3	Stimulate national integrated assessment capacity and exchange experiences	Notes and recommendations from TFIAM 53 and 54	TFIAM	National contributions
1.1.3.4	Integrate knowledge from science bodies in integrated assessment framework and support policy process with scenario analyses	Specification of "optimized scenarios", "optimized and equity scenario", "ozone precursor scenarios", "health in cities scenarios"	CIAM, MSC-W, TFHTAP, TFIAM	Additional resources required
1.1.3.5	Update, refine and further develop GAINS model, including new scientific findings on local health impacts, condensables, emissions of NOx and NMVOC from soil and implications of hydrogen economy. Update emission projections at global level, including mercury	Updated version of GAINS Updated assessment of emissions and projections of mercury at global level	CIAM	EMEP budget
1.1.4 Linking the scales				
1.1.4.2	Organize new global and regional model simulations of historical trends and future scenarios for Gothenburg Protocol pollutants with assessment of human health and vegetation impacts	Initial findings assessment (2025)	TFHTAP, TFMM, MSC-W, CIAM, ICP Vegetation	Parties' in-kind contributions

WP item	Activities	Outcome	Lead body(ies)	Resources
1.1.4.6	EPCAC activities	Activity report together with TFIAM report Annual meetings of EPCAC 5 and 6	TFIAM with nominated experts	Parties' in-kind contributions
1.2 Cooperation with Parties				
1.2.2	Stimulate national integrated assessment capacity in EECCA, Türkiye and West Balkan countries	Application of updated GAINS multiscale model/EMEP/uEMEP Workshop on GAINS scenarios	MSC-W and CIAM with CEIP, TFIAM, TFTEI	
1.2.3	Regular coordination with task forces and expert groups on CH_4, O_3, N	Meeting notes	TFIAM, TFHTAP, TF-Health, TFRN, FICAP	
1.3 Cooperation with other projects and bodies (outreach activities)				
1.3.1	Contributing to outreach work of FICAP, by providing technical content and guidance, including on emissions inventory compilation and management, non-technical measures and economic instruments	Emissions inventory guidance documentation (2024, 2025) Contribution to targeted webinars to be organized by TFICAP	TFEIP, TFIAM, TFMM	Additional resources required
1.3.8	Cooperation with Arctic Council and AMAP	Focus on BC in framework of European Union contract	CEIP, CIAM, MSC-W, secretariat	AMAP, Additional resources required
1.3.10	Promotion of guidance documents, including those recently adopted	Explore opportunities to promote guidance documents, including those recently adopted within and outside ECE	TFIAM	
Policy				
2.1 Analysis of policy-relevant information and follow-up to the review of the Gothenburg Protocol, as amended				
2.1.4	Promotion and use of multiscale modelling to inform regional and/or local air quality management.	Policy brief on multiscale modelling	TFIAM, TFICAP	

WP item	Activities	Outcome	Lead body(ies)	Resources
2.1.7	Analyse implications of NH_3 as energy carrier as part of decarbonization strategies, including possible emissions of NH_3, N_2O 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
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	TFRN in cooperation with TFIAM	Subject to availability of resources
2.1.12	Provide further analysis on potential implications of introducing collective risk-based targets for the UNECE region to address air pollution impacts on health and ecosystems	• Policy brief on this analysis	TFIAM	
2.2 Development and promotion of guidance documents				
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	
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	