

# AIR CONVENTION

(CONVENTION ON LONG-RANGE TRANSBOUNDARY AIR POLLUTION)

## Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (EMEP)

### **TASK FORCE ON INTEGRATED ASSESSMENT MODELLING (TFIAM)**

54<sup>th</sup> session, 03 - 04 April 2025  
Laxenburg, Austria and online

*Chairs report as of 16<sup>th</sup> of May*

### **Summary**

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 of most of the 8 proposed policy negotiation topics set out in EB decision 2023/05. The model update to better account for non-linearities in ozone chemistry is under way. Nevertheless, TFIAM requires guidance from the WGSR and its parties on details regarding scenario modelling, ambition levels and, more in general, staged and phased approaches to be effective in providing input to the revision of the Gothenburg protocol. Furthermore, modelling will benefit from feedback by parties on the data and assumptions used in GAINS.

TFIAM/CIAM presented the modelling results for the updated baseline and MTFR scenarios (scenario generation v5); these are included in the current version of the Policy Brief. Results presented refer to effects on pollutant emissions, exposure, and health and ecosystems impacts. The feasibility of reaching a 50% reduction in PM<sub>2.5</sub> related health effects over the UNECE region and in sub-regions were shown for both dynamic and static demography, as well as optimisation results for ecosystems. A specific item of the meeting focused on modelling of staged approaches for the EECCA & West Balkan countries and Türkiye.

Current GAINS modelling focuses on the feasibility of reducing exceedances of critical loads for nitrogen in specific ecosystems, joint optimisation for PM<sub>2.5</sub> related health effects and ecosystems effects (biodiversity) and assessing the impact on costs and benefits when imposing a more egalitarian cost-distribution across the parties. The analysis of reduction targets other than 50% is ongoing. The analysis of feasible reductions of health impacts from combined PM<sub>2.5</sub> and O<sub>3</sub> exposure is planned before the end of 2025. TFIAM also discussed the need for further guidance from the TF on Health for health impact assessment, including morbidity, while awaiting final reports on EMAPEC and HRAPIE 2 from WHO, and the need to include cost-benefit analysis in the TFIAM's work plan for 2026-2027. With respect to biodiversity modelling, the TF considers that the harmonised data set of the CCE on the empirical critical load of the biodiversity loss due to nitrogen deposition (CLempN) should be used for target setting, whereas the set based on choices by National Focal Centres is useful for sensitivity and ex-post analysis.

## I. INTRODUCTION

1. This report describes the results of the 54<sup>th</sup> session of TFIAM, held in Laxenburg Austria and online from the 3<sup>rd</sup> to the 4<sup>th</sup> of April 2025. The presentations made during the meeting and the reports presented are available at: <https://iiasa.ac.at/task-force-on-integrated-assessment-modelling-tfiam-past-meetings>. All material produced by TFIAM and the Centre for Integrated Assessment Modelling (CIAM) are available at: <https://iiasa.ac.at/policy/applications/task-force-on-integrated-assessment-modelling-tfiam-under-lrtap-convention>.
2. 47 experts participated in Laxenburg, and almost 60 online. These represented the following Parties to the Convention: Armenia, Austria, Belgium, Canada, Croatia, Czechia, Denmark, the European Union, Finland, France, Georgia, Germany, Hungary, Ireland, Italy, Kazakhstan, Malta, the Netherlands, Norway, Poland, Portugal, Serbia, Spain, Sweden, Switzerland, the United Kingdom of Great Britain and Northern Ireland, and Russia. 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), WGE Coordination Centre for Effects (CCE), 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) and the Task Force on International Cooperation on Air Pollution (TFICAP). In addition, the Joint Research Centre of the European Commission (JRC), the German Bund für Umwelt und Naturschutz Deutschland (BUND), the European Environment Bureau (EEB), and CONCAWE were represented.
3. Stefan Åström (Sweden) and Simone Schucht (France) chaired the meeting.
4. The IIASA Deputy Director General Karen R. Lips opened the meeting. The Deputy Director highlighted the need to focus on establishing strong and transparent science related system analysis of common global environmental challenges.

## II. NEWS FROM THE CONVENTION AND OBJECTIVES OF THE MEETING

5. TFIAM noted the presentations by the TFIAM co-chairs 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. TFIAM are also to support the Air Convention in developing qualitative guidance for the development of scenarios.

### III. GOTHENBURG PROTOCOL REVISION

7. TFIAM noted the presentation by Panagiota Dilara from the European Commission on discussions and conclusions from the TAIEX regional workshop on Emissions Inventories and Integrated Assessment Modelling: supporting candidate countries that took place from 31 March to 2 April 2025 in Vienna. The meeting showed the need for solutions that are adapted to current non-Parties to the Gothenburg Protocol, both with respect to methodologies and emissions factors as well as priorities for modelling. The participants expressed interest in further workshops and bilateral cooperation. The general discussion of modelling priorities for these countries included issues of non-economic barriers and opportunities for specific sectors. Analysis for 6 countries were carried out by TFTEI and more are planned. It will be important to obtain the views of the Heads of Delegations (HoD) with respect to modelling priorities and information relevant to scenarios. The experience from the TAIEX meeting suggests that there is not one single optimal approach for the whole region.

8. TFIAM noted the presentation by the Chair of the Working Group on Strategies and Review (WGSR), Till Spranger, on the current requirements for the revision of the Gothenburg Protocol (GPR) of specific concern for TFIAM. The chair gave an overview of the past and current process informing the revision of the Gothenburg Protocol. As a reminder, the current revision process has eight main negotiation items:

- a) New emission reduction commitments,
- b) Technical annexes,
- c) Black carbon emission reductions,
- d) Whether and how to address methane emissions,
- e) Additional ammonia emission reductions,
- f) Flexibilities for present non-Parties,
- g) Overarching, collective risk-based target(s),
- h) Integrated approaches between climate, energy and air.

9. The Chair of WGSR also reminded TFIAM of the integrated assessment modelling (IAM)-related conclusions from the Executive Body (EB) in its 44<sup>th</sup> meeting, e.g., that the overarching collective goals should be aspirational and not necessarily have the same ambition levels as the emission reduction commitments, and that TFIAM should provide effects-based scenarios at different ambition levels. During following discussions, it was clarified that TFIAM/CIAM is to perform optimization with respect to human health and biodiversity goals. Detailed effects for acidification and eutrophication will be analysed in ex-post analysis.

10. TFIAM noted the presentation on IAM modelling developments given by the head of CIAM, Zbigniew Klimont. He presented current work and future options to analyse phased and staged approaches with the GAINS model for the West Balkan and EECCA and Türkiye region. Staged approaches refer to preferred sectors in which to apply mitigation measures, phased approaches could refer to targets for certain regions being achieved at different time scales. Preliminary scenarios assume that EECCA, West Balkan countries and Türkiye will meet EU emission limit values and standards for four main emission sectors by 2040 (transport, industry, power plants, and residential combustion). For West Balkan, this staged approach would imply distinctively larger emission reduction effort in residential combustion, compared to the cost-effective

solution. For EECCA and Türkiye, additional effort would be higher in the transport sector, compared to the cost-effective case. The analysis shows that staged approaches can provide important health improvements but at higher costs compared to the cost-effective solution. TFIAM and CIAM need advice on how to proceed especially for phased approaches.

11. TFIAM noted the presentation by Gregor Kiesewetter from CIAM on urban downscaling in the GAINS model. Exposure increment coefficients for local primary PM (PPM) based on uEMEP model simulations can now be applied for the entire European UNECE region. These reflect higher contributions to concentrations from low level local sources (transport, residential heating). Scenario analysis for EECCA and Türkiye and West Balkan shows that the cost-effective scenarios addressing health objectives, developed under the Gothenburg Protocol revision process, would also improve urban air quality. Although disparities between rural/urban populations are likely to remain, the scenarios lead to relatively higher improvements in air quality in the urban regions compared to the rural regions. Further, the scenarios suggest that urban peak concentrations will be reduced.

12. The representative from the United Kingdom reminded TFIAM about the EB 44 decision that parties should assist parties in need to produce and analyse data for indicative emission reduction commitments.

13. TFIAM noted the presentation by the TFIAM advisor Rob Maas on the negotiation process and the use of models in this process. The presentation provided a step-by-step overview of how parties have used information provided by integrated assessment modelling in previous negotiations of the GP, as well as on information that national decision makers need to provide to modellers for them to produce useful results for the policy process. The presentation underlines that models are there to help, not to dictate negotiation positions, and that decision makers should carry out own analyses at the national level.

14. TFIAM noted the information about an informal EU workshop on methane in the context of the GP revision that took place in March 2025, given by Panagiota Dilara from the European Commission. European Union Member States had asked for this workshop when it was decided by the Executive Bureau in December 2024 to not establish an ad-hoc group on methane. Presentations were given by scientists and representatives of different bodies of the Air Convention and European Commission Directorates General, followed by discussions by the Member States. The EU countries hope to have a common EU position on whether and how to address CH<sub>4</sub> ready by WGSR 63.

15. TFIAM noted the presentation by Simone Schucht on the 4<sup>th</sup> version of the scenario policy brief published by CIAM and TFIAM. The policy brief outlines the different policy scenarios and presents corresponding impacts on emissions, health, and ecosystems. It explores the feasibility of reducing health and ecosystems effects. The current version presents cost-optimal solutions to reach an indicative 50% reduction in mortality from PM<sub>2.5</sub>. Least cost solutions and alternative more egalitarian approaches are analysed for the target year 2040. The analysis shows that results differ depending on whether dynamic or static demography are used in the analysis. The indicative 50% PM<sub>2.5</sub> related health target can be reached for the United Nations Economic Commission for Europe (UNECE) region overall, but not in every country. If assuming implementation of non-technical measures, a 50% health target is easier to achieve. Reducing ozone impacts by 50% will be more challenging as reductions in ozone

require reductions of all precursor emissions (NO<sub>x</sub>, NMVOCs, CO, CH<sub>4</sub>) and cooperation by all countries, even outside the UNECE. A 50% reduction in Accumulated Average Exceedance (AAE) of empirical critical loads for nitrogen deposition (CLempN) is feasible across all ecosystems analysed together, but not in every ecosystem type.

16. In the discussion the relevance of one of the outcomes from the WHO-hosted Second Global Conference on Air Pollution and Health in Cartagena, Columbia, was stressed, namely that the participants agreed on a target to reduce human health impacts from air pollution by 50%.

17. TFIAM noted the presentation by the head of CIAM on progress in the development of the GAINS model as well as the ongoing scenario analysis for the Gothenburg Protocol revision. CIAM has developed an updated version of the Baseline (Baseline or current legislation - CLE) scenario (v5) considering latest inputs from other projects like the Fourth EU Clean Air Outlook, a maximum technical feasible reduction (MTFR) scenario, and also first cost-optimal solutions for achieving a reduction of 50% mortality from PM<sub>2.5</sub> by 2040, compared to 2015, both for dynamic and for static demography. The emission data have been made available on the CIAM website. As a latest improvement, in addition to the mortality target, risks for biodiversity have been included in GAINS optimization, expressed in terms of AAE for empirical critical loads for nitrogen deposition. While a tentative 50% reduction of AAE (using the lower range of the CLempN provided by CCE in April 2024) by 2040 compared to 2015 is feasible for all ecosystems combined, this is not feasible for individual grassland ecosystems, where biodiversity (e.g. plants species, butterflies and birds) is more sensitive to excess nitrogen. A less stringent target of -40% is achievable for all but two ecosystem types, for which there was no target set in this initial analysis. CIAM has developed a GAINS *Explorer*, an online tool enabling easy access to Gothenburg Protocol revision scenarios and easy comparison with other scenarios. This is not possible in the full GAINS online model because the activity data in the PRIMES energy scenario, that are used GAINS, are not yet made public.

18. As in previous years, TFIAM stresses the importance of CIAM being authorised to share the activity data underlying the emission scenarios produced for the Gothenburg Protocol revision. Parties cannot verify emission assumptions in GAINS without knowing the assumptions on economic activity. Therefore, **TFIAM requests the European Commission to share their underlying activity data used in the GAINS scenario calculations.**

19. Further recent modelling results include joint optimization of health and biodiversity targets. Achieving 50% reduction in PM<sub>2.5</sub> mortality brings large co-benefits for biodiversity. Joint optimisation for health and biodiversity impact reductions implies further reductions in NO<sub>x</sub> and NH<sub>3</sub> emissions but shows slight increase in SO<sub>2</sub> emissions compared to the optimisation only for the health target. Sulphur emissions increase because further emission reductions of nitrogen that are needed to protect biodiversity have as a co-benefit a decrease in the formation of secondary fine particulate matter. Therefore, there is less need to control sulphur emissions for a given human health target alone.

20. Gregor Kiesewetter from CIAM presented the results of assessments of the feasibility to reduce biodiversity effects by 50%, using the CCE background dataset as a basis. A 50% reduction of exceedances of critical loads by 2040 can be achieved in the majority of habitat types, but the technical measures available in GAINS are not

sufficient to reach such reductions in some of the most sensitive ecosystems types. These are very nutrient-sensitive grasslands. Analyses by CIAM show that a 40% reduction in AAE would be feasible for all except two habitat types, which would nevertheless see significant improvements too (about 35%).

21. CIAM recently started analysis of more egalitarian approaches in terms of the distribution of abatement costs across parties. When exploring different levels of caps on the maximum percentage of additional abatement costs per gross domestic product (GDP) in a country, CIAM finds (for the discussed health target) that up to a limit of these costs to 0.5 % of GDP, overall costs are not significantly increased. However, limiting maximum expenditure further, the total costs would become much higher, until the model is not able to calculate an optimal solution anymore. With a cap of ~0.2% of GDP, the relative costs for the country that pays the most (as % of GDP) is still 100 times higher than for the country that pays the lowest % of GDP. Discussions following the presentation pointed out that an equity assessment should also consider benefits. It was agreed that cost-benefit analysis (CBA) of the scenarios supporting the GPR was needed.

22. Work is ongoing with MSC-W to include ozone in GAINS and assess combined targets for PM<sub>2.5</sub> and ozone related mortality and ecosystem risks. Initial analysis of policy scenarios considering such combined targets are planned to be ready by autumn 2025. The non-linear nature of O<sub>3</sub> chemistry could be then taken into account in GAINS calculations, thanks to successful collaboration between CIAM and MSC-West.

23. TFIAM noted the presentation by Mike Holland on recent developments in the quantification and economic valuation of health effects. Recent publications under the WHO EMAPEC (Estimating the morbidity from air pollution and its economic costs) and HRAPIE 2 (Health Risks of Air Pollution In Europe) projects show that recent research suggests even more health effects from air pollution than previously known. The HRAPIE 2 papers and other reviews also provide more information on response functions for mortality related to PM<sub>2.5</sub> and NO<sub>2</sub>. There is no evidence of lower thresholds below which no health impacts from pollution would occur, as there are only few studies made in low-concentration environments. The mortality estimates of ozone remain difficult. Of the available studies, there are large variations in effects between regions of the world. Further questions arise as to whether the aggregation of health costs from different health endpoints might lead to double counting. The final reports by WHO on the two projects EMAPEC and HRAPIE 2, and exchange with the TFH will be useful in making decisions on the health impact analysis methods for the revision of the Gothenburg Protocol.

24. TFIAM noted the presentation by Guus Velders, co-chair of the Expert Panel on Clean Air in Cities (EPCAC), on the EPCAC position paper on clean air in cities. The paper discusses the air quality in cities, the contribution of sources of air pollution, the possible policy measures, as well as the governance level (local, national, regional, international) at which effective policies would have to be designed. Of key importance for TFIAM is that there appears to be a difference between the GAINS model and the SHERPA model (by JRC) with respect to the emission sector contributing most to PM<sub>2.5</sub> concentrations in ambient air of cities belonging to specific regions. For Western Europe, GAINS modelling suggests that road transport contributes most to PM<sub>2.5</sub> concentrations in cities, whilst SHERPA suggests residential combustion in most of Western Europe and agriculture in the Benelux countries.

25. TFIAM suggests a model intercomparison between the SHERPA and the GAINS model to better understand the origins of differences in model results.

26. The EPCAC Position paper also shows to what extent city-level air quality management is dependent on cooperation with regions outside of the city.

27. TFIAM noted the presentation by Markus Geupel, head of the CCE. He presented the work and processes leading to two data sets of empirical critical loads for nitrogen (CLempN), which were delivered to CIAM in March 2024 and February 2025, respectively. The first set consists in a harmonised set of CLempN for the whole European UNECE region. Exceedances of the CLs relate to changes in biodiversity. This is the data set for which CIAM presented results with respect to minimum and average levels of these critical loads.

28. The link between Empirical Critical Loads and EU nature policy requirements are not explicit. However, the CLempN is often used nationally as indicator for the ecosystem protection level. The CCE report summarizes in chapter 10 the links to EU biodiversity policy. The use of the minimum level is considered to be in line with the precautionary principle in the Natura2000 Directive. However, CCE considers that this interpretation of the precautionary principle is not the only legal way to be in compliance with the Natura 2000 Directive.

29. The second data set (of February 2025) includes contributions from 12 National Focal Centres (NFCs) following a call for data. As countries make different choices with respect to the CLs they report, this data set is not harmonised. For countries not having reported national data, the average over all nationally reported CLs was applied. The difference between the minimum critical load level in the CCE March 2024 data and the CCE February 2025 data indicate higher critical loads for nitrogen the latter. They correspond with the average critical load level. The exception is Norway, where the national reporting (March 2025) indicates a lower critical load for the entire region, the March 2024 data imply higher exceedances as well as larger areas with CL exceedances than the national preferences in the March 2025 data.

30. The ICP on Mapping and Modelling proposed to use the data set based on NFC data for analysis supporting the Gothenburg Protocol Revision. The discussion that followed this presentation was about which data set to use for target setting and to what extent it is the role of scientific bodies to recommend policy choices for their data sets. Given that the request from the Executive Body was to analyse “*Overarching, collective, risk-based target(s) to reduce harmful effects ... to ecosystems, including biodiversity loss in the ECE region*”, a harmonised data set appears to be more appropriate. However, the data set based on NFC data can be used in ex-post analysis and sensitivity analysis.

31. TFIAM noted the presentation by Tim Butler, the co-chair of the TF HTAP, giving an overview of the HTAP work, which includes plans for global modelling of CIAM scenarios for the Gothenburg Protocol revision, ongoing work on mercury and further plans for multi-pollutant impacts of fires. The draft workplan for 2026/27 includes 7 shared items with TFIAM that relate to scenario development and the development on source receptor relationships. Next to the baseline and MTFR scenarios from CIAM, HTAP will model a HILO scenario that combines CLE assumptions for methane emissions and MTFR assumptions for all other ozone precursors. Concentrations of methane are higher in the HILO scenario than in the CLE scenario. Ensemble modelling of approximately 12 Chemistry Transport Models based on CLE2040 will be used to

understand source-receptor relationships and uncertainties. On this basis, HTAP will develop an emulator to more quickly assess further scenarios. A description of the planned exercise is available in an online paper. HTAP will use comprehensive Chemistry-Climate Models to understand chemistry climate relationships, including the possible climate penalty for ozone and the climate impact of the scenarios in terms of radiative forcing. HTAP also analyses the hemispheric contribution to European background ozone. Model simulations in this exercise will begin soon, first results are expected for September 2025 and hopefully preliminary analysis by Spring 2026 for WGSR. More will be available for EB 2026. If the GP revision process continues beyond 2026 more analysis can be provided. HTAP also plans an activity on the impact of wildfires and agricultural burning on air quality. The objective is also to include the climate driven feedback to fires, increasing future fires. The next TF HTAP meeting takes place from 5 to 7 May in Potsdam back-to-back with TFMM. Depending on the ozone metrics relevant for health impact assessment, analyses by HTAP will cover runs over 6 months (for peak season ozone) or a full year (for annual concentrations). This calls for exchange with TFH on the most likely recommendations for the health metric most useful for HIA.

32. TFIAM noted the presentation by Stefan Aström, co-chair of TFIAM, of the TFIAM guidance document on behavioural and non-technical measures (NTMs). Comments provided by parties were accounted for in the final version submitted to WGSR-63 (except for Canada's comment on introducing more examples of best practices). Sectors looked at are transport, residential heating (wood burning), and also agriculture through dietary change. The report found that some of the available effective behavioural changes are not popular (e.g., reducing wood burning, changing diets). Nevertheless, NTMs provide a substantial additional emission reduction potential on top of technical measures. The most effective measures seem to encounter the highest political resistance. Also, there is not one sole good solution to bring about behavioural and structural measures. What works in one country does not necessarily work in others, therefore it is difficult to extrapolate assessment results to other locations, countries and regions. Given the emission reduction potential of NTMs, it remains important to evaluate examples and exchange experiences. The guidance document was submitted to WGSR 63 and will be forwarded after discussion to EB for adoption.

33. In the discussion following the presentation, it was highlighted that behavioural measures have both negative and positive welfare impacts, and that in current CBA the perceived disadvantages of changing behaviour are not yet consistently included. This issue will be relevant for a CBA of the LOW scenario.

34. TFIAM noted the request from Finland for a scientific rationale for the 50% policy targets currently assessed by CIAM/TFIAM, as well as the rationale to include emission reductions for black carbon, ammonia, and methane. The scientific rationales are documented in the Gothenburg Protocol Review reports, which were adopted by EB42 (EB decision 2022/4). The document numbers are ECE/EB.AIR/2022/3, and ECE/EB.AIR/2022/4.

#### IV. FURTHER MODEL DEVELOPMENT

35. TFIAM noted the presentation by Margherita Tolotto from EEB of an exploratory study on 10 technical and non-technical measures to cut air pollution and reap climate co-benefits which were assessed to understand their contribution to meeting existing EU legislation (namely the Ambient Air Quality Directive, AAQD). The study assesses the impact of a set of measures for a group of countries in terms of air pollution and climate co-benefits and then implemented these in an assessment for Europe. Starting from country projections provided under the National Emission reduction Commitment Directive (NECD), the gap to meeting the AAQD was analysed. Three energy measures, three agricultural measures and three transport measures were analysed. According to the study, the implementation of these measures would allow meeting the AAQD limit values for 2030. However, the model resolution of 50x50 km makes these results uncertain, a finer spatial resolution would be needed. The study also assessed the measures in terms of costs, but not yet in terms of economic benefits. Benefits in terms of avoided health effects were assessed. The overall conclusion is that the study underestimates the benefits, inter alia because of the low spatial resolution of the model. The environmental impact assessment was limited to effects of O<sub>3</sub> on crop yield. Overall conclusions are that the EU can meet by 2030 the AAQD limit values under the baseline scenario when implementing behavioural or non-technical measures. Co-benefits in terms of avoided CO<sub>2</sub> and CH<sub>4</sub> emissions would be high. TFIAM concluded that further investigating NTMs and introducing them into assessments is important.

36. TFIAM noted the presentation by Claudio Belis from the JRC of an assessment of health impacts and costs from air pollution in Western Balkan cities. This was a preparatory study to develop for the FASST tool. The analyses use measures from local monitoring stations on top of those reported to EEA. The health impact assessed is mortality, monetised using both, the Value of Statistical Life (VSL) and the Value Of a Life Year (VOLY) based on the assessment by OECD, 2012, and adapted to the different countries on a GDP/capita basis. An average value for the region was also used. The study compared results for all-cause mortality with results for cause-specific mortality (6 causes) for exposure to PM<sub>2.5</sub> and all-cause mortality for exposure to O<sub>3</sub> and NO<sub>2</sub>. PM dominates mortality over the region, relative to NO<sub>2</sub> and O<sub>3</sub>. Source apportionment of avoided mortality (monetary benefits) was carried out using SHERPA. Claudio Belis also reported further publications. An econometric study in which meta-regression analysis is used to estimate VSL and VOLY associated to air pollution at a global level, and two recent JRC reports on Environment and Climate in the Western Balkans and in Ukraine, respectively.

37. TFIAM noted the presentation by Enrico Pisoni, JRC, on an update from the FAIRMODE network. A first issue concerns modelling in the revised AAQD which now includes 79 references to modelling and includes mandatory tasks. This requires changes also in the FAIRMODE network. Modelling systems are to be used, competent authorities need to be designated by member states, modelling needs to meet a quality standard etc. There is also a wish to promote more harmonised air quality modelling through a European network applying best practices. Intercomparison exercises are to be carried out and the models are to be reviewed regularly. The FAIRMODE working group (WG) 1 analysed source apportionment with respect to the geographical variability by pollutant, geographical level and sector. It found that meteorology plays a minor role, most important for the variability of results are the underlying emission inventories. This study will also be applied to analyse origins of differences in results between GAINS and SHERPA for the EPCAC position paper. The WG2 deals currently

with the question of the minimum number of stations necessary for obtaining robust results. Evaluation of the Model Quality Indicator (MQI) for different models was carried out for several countries and distinguished between all stations versus background stations. For PM<sub>2.5</sub> the MQI needs to be more stringent in order to track whether a model is fit for purpose. WG 5 on planning carries out work on bias correction in projections. The question is about how to introduce knowledge on a model bias in the base year into projections. A benchmark exercise is carried out with synthetic data and is submitted to different countries. It is hoped that recommendations will be derivable from this exercise. Starting from a perturbed data set countries have to develop the projection which is then compared to the base case (scenario) to which it should be as close as possible. This exercise is ongoing.

38. TFIAM noted the presentation by Ebba Malmqvist (AirClim and Lund University) on latest evidence on health effects of black carbon (BC), PM<sub>2.5</sub> and ozone and related gaps in knowledge. New strong evidence was published under the ongoing WHO projects EMAPEC and HRAPIE 2 for mortality and morbidity impacts of air pollution. Relative risks (RRs) for PM<sub>2.5</sub> related all-cause mortality have increased over time, and there is no doubt about the evidence of the effect from PM<sub>2.5</sub>. For health effects from ozone there is much evidence on acute effects, and less but increasing effects on chronic effects. Work on ozone by the United States Environmental Protection Agency (US EPA) which was last updated in 2020 takes a broader view than WHO by including not only epidemiological studies but also chamber analyses when deriving knowledge on the causality about health effects. A workshop in 2024 reported new evidence for further health effects from ozone (brain impacts, COPD) and also showed evidence that there might be no exposure threshold below which no health impacts occurred. Recent meta-analysis under HRAPIE 2 shows high evidence for respiratory disease and COPD related mortality from ozone. There is now also evidence on long-term exposure to ozone and related health effects, specifically respiratory mortality and annual ozone levels. BC is thought to have impacts on health, with sufficient evidence available for short term exposure, whereas the evidence from long term evidence is currently non conclusive, but emerging. There is increasing evidence that BC and combustion related primary particles in general are not good for health. A WHO report on BC and health effects, including if effects are independent of PM<sub>2.5</sub> effects, is expected by the end of the year.

39. Discussions following the presentation highlighted that it would be useful to present this evidence from WHO at the Heads of Delegates (HoD) meeting in October in Denmark, as this meeting will specifically deal with the three substances (BC, CH<sub>4</sub>, NH<sub>3</sub>) to consider with priority in the revision process.

40. TFIAM noted the presentation by Stefan Reis about an integrated assessment project on air pollution from agricultural emissions and dietary change and their effect on public health in the UK. The aim of the project was to assess what contribution emission reductions from agricultural production can make to reduce the exposure of the population to PM<sub>2.5</sub>. Looking at impacts of specific interventions the study also assessed co-benefits of dietary change. A multi stakeholder group was convened to delineate existing and additional future policies for air pollution and greenhouse gas reduction. Modelling was used to quantify changes in mortality and morbidity due to changes in air pollution by 2050. In terms of health modelling, the analysis used combined RRs for air pollution (PM<sub>2.5</sub>) and dietary consumption. Selected results indicate changes in livestock numbers and land area that depend on scenario assumptions (measures assessed). Combination of on-farm measures and dietary

change reduces agricultural ammonia emissions and PM<sub>2.5</sub> emissions and concentrations. Health benefits would be highest from combined high ambition scenarios combining low emission farm measures and measures pushing towards dietary change. Dietary change can bring greater health benefits than reductions in PM exposure from agricultural activity. Lower ammonia also reduces impacts on ecosystems. More research is needed to provide robust evidence whether health effects from PM in the form of secondary inorganic aerosols, including ammonium nitrates and sulfates, carry the same level of health risks as exposure to primary fine particulate matter emitted from combustion processes.

## **V. PROGRESS OF ASSESSMENT MODELLING BY PARTIES**

41. TFIAM noted the presentation by Simone Schucht (France) informing about the objectives of a French research project on co-benefits of low carbon strategies in France. The project aims at developing a more integrated modelling of air pollution and energy policies instead of the current unidirectional modelling of energy policies and subsequent analysis of air quality and health impacts, so as to favour the choice of synergetic measures and avoid trade-offs between climate and air policies. To this end it established a soft link between the energy model POLES and the IAM GAINS, thus integrating emission and cost factors for air pollution abatement technologies into the POLES model. Furthermore, estimates of damage costs (health and environment) by tonne of pollutant were also added to the energy technology costs in the POLES model. The integration of air pollution abatement costs into POLES reduces the air pollution impact of the modelled scenarios, although the impact on the energy mix is limited. The introduction of damage costs per tonne of air pollutants into POLES has even stronger effects on the air pollutant emissions of the resulting model choices. Further assessment is necessary to ensure that the results represent optimal technological choices. Within the project, the surrogate model Air Control Toolbox (ACT, CAMS) was further developed to explore multiple scenarios and assess the relative impact of individual activity sectors in the mitigation potential. The study is about to be published.

42. TFIAM noted the presentation by Helen ApSimon and Huw Woodward (United Kingdom of Great Britain and Northern Ireland) who presented results from national scenario analysis in the UK up to 2050. England has a Population Exposure Reduction Target (PERT) set for 2040 relative to 2018 and an Annual Maximum Concentration Target (AMCT). Compliance is assessed not only against PM<sub>2.5</sub> but also for primary PM, secondary inorganic aerosol (SIA), and secondary organic aerosol (SOA). The presentation put emphasis on different (types of) uncertainties inherent in modelling (uncertainties in emission factors, in energy projections, and different ways in reaching net zero...). the analysis indicates benefits of all net zero strategies, but they change depending on how net zero is achieved and which EFs are used. Various methods are used to assess uncertainty in pollution scenarios. Sensitivity studies, model intercomparison, measurement vs model results. A focus is put here on which uncertainties are the most important and to which extent they can be quantified. Gaps and uncertainty priorities for assessment were analysed based on a qualitative hierarchisation. The study identified priority sectors for which uncertainty should be assessed and reduced as they were considered most potentially impacting on meeting the UK PERT targets. The team are working towards a framework for consistent treatment of uncertainties.

43. TFIAM noted the presentation by Christian Lange, Denmark, on the recent Danish initiative on farming and nature restoration, decided under the agreement on a green Denmark. Key elements of the agreement are climate, afforestation, a better aquatic environment and a more sustainable agricultural sector. A tax on CO<sub>2</sub> and CH<sub>4</sub> emissions from cattle livestock was negotiated amongst a farmer organisation, NGOs and government and should be introduced in 2030, with levels increasing over time. A tax on drained peatland from 2028 is also foreseen whereas a tax on agricultural lime is less likely to be put into practice. It is the first time that the government will buy land to bring about use changes: afforestation and rewetting of carbon rich drained peatlands. Seven national parks will be created. Funding comes from the Green Fund, reallocation of funds from the common agricultural policy (CAP) and a Nordic fund. All this is meant to contribute to meeting Danish climate targets. There will be less farmable land and more nature and biodiversity.

44. TFIAM noted the presentation by Thomas Hammerbauer and Barbora Pochtova Vodickova (Czech Republic) on assessing emissions of greenhouse gasses (GHG) and air pollutants from the energy sector with the TIMES model. CHMI is responsible for reporting of GHGs and Air pollutants. The motivation for investing in the modelling was to improve the reporting. The model allows for different regional scales. Emission projections were developed within the project ARAMIS that also facilitates collaboration with different stakeholders providing data. Projections are developed up to 2050 with information of subsectors of the energy sector. Both GHG and air pollutant emissions are projected to decrease. Keys to the reduction are legislative acts/regulations as well as economic pressure (pollution fees), pressure to install best available abatement technology (BAT) and to replace carbon-based fuels by low emissions fuels. The TIMES model is now further developed, including more detail and technologies for the energy sector, with a division of the region into sub-regions, thus ensuring consistency with national and EU policies. Coal is projected to be phased out, moving to solar and nuclear power plants. Integrating driving forces, the model allows for exploring future scenarios. CHMI consider their projections to be in line with those from the GAINS model.

45. TFIAM noted the presentation by Siemen Timmermans (Belgium, VITO) on the project Industrial outlook 2050 - The emission changes related to a transitioning industrial landscape in Flanders. Guiding questions of the study are: what happens to air pollutants under current climate scenarios, what are preferred climate options and what are the air quality risks of specific climate technologies. The project is linked to the Flemish air quality plan with objectives up to 2030 and also to more long-term policies that need to be developed up to 2050. The analysis starts from the climate side and looks at impacts for air pollution. Results are currently discussed by the stakeholders and will be made public later. The TIMES model was used for identifying the technological options for different energy products (current and future). Emission factors were then associated with the different technologies. Emission factors were often provided by industry especially for existing technology, otherwise other sources were used (EMEP/EEA guidebook, BREFs, literature search...). This resulted in a technology explicit list with emission factors, deployment limits and other information. The information was included into a tool comprising informative technology sheets to analyse the impact of the technology and an impact dashboard to analyse the impact of a package of measures. Users can use these tools to analyse and visualize scenarios and results.

46. TFIAM noted the presentation by Stefan Aström (Sweden) of a study on the NH<sub>3</sub> and CH<sub>4</sub> cobenefits of agricultural measures in the Nordic countries. The objective is to identify measures that reduce both pollutants, and to propose strategies that have positive effects on climate and air pollution. Dietary change was not considered in this study. Based on literature and regulatory study a data base was developed containing measures with best co-beneficial characteristic. The focus was on emissions of NH<sub>3</sub>, N<sub>r</sub> and CH<sub>4</sub> from agriculture in Sweden, Denmark, Finland, Iceland and Norway. NO<sub>x</sub> and N<sub>2</sub>O were also accounted for. The most effective multi pollutant measures were identified. They include a combination of technical and political solutions (e.g. land use techniques). Coordinated efforts between farmers, policy makers and other stakeholders are important for effective implementation. Also, coordination between different policy areas would be beneficial. Finally, effective monitoring of emissions at farm level is important. Improving the management of manure and the application of fertilisers is amongst the key co-beneficial measures.

47. TFIAM noted the presentation by Ilaria D'Elia (Italy) of a scenario intercomparison with 5 IAMs in the Po Valley for 2030 to address IAM uncertainties. The integrated assessment model intercomparison involved MAQ, SHERPA, GAINS-Italy, SIMBAD, and RIAT+, which differ in characteristics, some parameters and input data (resolution, emissions of base case, different met years...). Measures included are those foreseen in national or local air quality plans. Results are presented at the administrative level (region, province, municipality) and the baseline compared to EEA results. The scenario results for the year 2030 are presented in terms of PM<sub>2.5</sub> emissions, concentration and attributable deaths. Emissions, except for VOCs, are relatively comparable across the models. Modelled PM<sub>2.5</sub> concentrations exceed the air quality limit values of the new European Air Quality Directive in 2030. Attributable deaths and YOLL were calculated in a consistent manner across the models. Overall, they lead to the same conclusions, in terms of the sign of the impact, although exact levels are different.

## **VI. CURRENT AND FUTURE WORK PLAN**

48. The 2024-2025 work plan is shown in the Appendix 1 to this report.

49. TFIAM are grateful to the European Commission for the invitation to have the TFIAM55 in Brussels. Date is yet to be decided.

50. Plans for the 2026/2027 workplan are shown in Appendix 2 to this report.

## VII. KEY CONCLUSIONS FROM TFIAM 54 AND RECOMMENDATIONS TO WGSR 63

51. TFIAM concludes that TFIAM/CIAM are well set up to support with GAINS modelling and scenario analysis the Gothenburg Protocol revision with respect to most of the 8 proposed policy negotiation topics set out in EB decision 2023/05 for the revision of the Gothenburg protocol.

52. TFIAM concludes that both in national and international modelling improvements have been made with respect to integrated analysis of air and climate policies.

53. To ensure possibility for parties to review CIAM/TFIAM work, **TFIAM recommends that relevant European Commission DGs authorise CIAM to share the activity data sets with the parties to the Air Convention.**

54. TFIAM recommends that **a cost-benefit analysis should be carried out quantifying benefits for human health and ecosystems from a set of scenarios** and comparing these with the GAINS cost estimates for additional measures.

55. TFIAM should develop a proposal for the health effects of air pollution to be considered in health impact assessments and CBA, the concentration-response functions to be used for mortality and morbidity with an indication of the uncertainty involved. This proposal should be submitted to TF Health for feedback.

56. TFIAM concludes that the request for IAM modelling of biodiversity effects to analyse *“Overarching, collective, risk-based target(s) to reduce harmful effects ... to ecosystems, including biodiversity loss in the ECE region”* (EB Decision 2024/2 and ECE/EB.AIR/2024/5), corresponds best to the use of a harmonized UNECE-wide data set with a consistent treatment of the risk of biodiversity loss.

57. Therefore, TFIAM recommends that CIAM cost optimization modelling with GAINS is made using the minimum and average levels of the CLempN harmonised background data set delivered by CCE to CIAM. It further recommends that the NFC-based data set delivered in February 2025 be used for ex-post analysis, as also recommended by WGE (ECE/EB.AIR/WG.1/2024/2).

58. TFIAM acknowledges that there are uncertainties of varying importance affecting IAM optimization results. These should consistently be taken into account for the most relevant sources of uncertainty. Of key importance for TFIAM are uncertainties that reduce the robustness of policy-relevant conclusions.

59. TFIAM needs further guidance from WGSR on ambition levels for health and biodiversity targets that should be analysed. In addition, clarity is also needed on how to focus analyses of staged/phased approaches.

## Appendix 1: 2024-2025 Workplan items

Decided at the 43<sup>rd</sup> Executive Body of the Air Convention

WP item	Activities	Outcome	Lead body(ies)	Resources
<b>Scientific activities</b>				
<b>1.1 Improving tools to assess air pollution and its effects in the United Nations Economic Commission for Europe region</b>				
<b>1.1.1 Monitoring and modelling tools</b>				
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, TFIAM, TFHTAP	TFMM, CIAM, EMEP budget
1.1.1.6	Update GAINS for simulating O <sub>3</sub> 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 <sub>3</sub> and health		Additional resources required
<b>1.1.2 Emission and projection tools</b>				
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 IIASA/CIAM	with 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, TFMM, CIAM, 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, TFHTAP, WGE	MSC-W, TFIAM, EMEP budget
1.1.3.2	O <sub>3</sub> modelling of future scenarios	Organize new global model simulations of future scenarios developed by CIAM, including examination of role of CH <sub>4</sub> , source attribution methods, link to regional scale and impacts	TFHTAP, CIAM, W, ICP	TFIAM, MSC-W, 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, TFHTAP, TFIAM	MSC-W, 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 NO <sub>x</sub> 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
<b>1.1.4 Linking the scales</b>				
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, MSC-W, Vegetation	TFMM, CIAM, ICP Parties’ contributions in-kind

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
<b>1.2 Cooperation with Parties</b>				
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 <sub>4</sub> , O <sub>3</sub> , N	Meeting notes	TFIAM, TFHTAP, TF-Health, TFRN, FICAP	
<b>1.3 Cooperation with other projects and bodies (outreach activities)</b>				
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	
<b>Policy</b>				
<b>2.1 Analysis of policy-relevant information and follow-up to the review of the Gothenburg Protocol, as amended</b>				
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	

<b>WP item</b>	<b>Activities</b>	<b>Outcome</b>	<b>Lead body(ies)</b>	<b>Resources</b>
2.1.7	Analyse implications of NH <sub>3</sub> as energy carrier as part of decarbonization strategies, including possible emissions of NH <sub>3</sub> , N <sub>2</sub> O and NO <sub>x</sub> , 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	<ul style="list-style-type: none"> <li>(a) Information document on benefits, including co-benefits, and barriers of dietary change, possible scenarios and opportunities to overcome barriers</li> </ul>	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	<ul style="list-style-type: none"> <li>Policy brief on this analysis</li> </ul>	TFIAM	
<b>2.2 Development and promotion of guidance documents</b>				
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, TFTEI	TFRN,

## Appendix 2: Suggestions for the 2026-2027 Workplan

### SCIENCE

Expected outcome/deliverable	Lead body(ies)	Resource requirements and/or funding source
Assessment of reduction options for the GP revision, and development of further scenarios	TFIAM/CIAM, ...	
Further explore the cause of differences in source attribution and effectiveness of emission reductions between models like EMEP/GAINS, JRC/Sherpa, Chimere, and local/national IAMTFIAM/EPCAC modelling experiences	TFIAM/EPCAC	
Report on methods for health risk/impact assessment of air pollution and cost-benefit analysis (recommendations from HRAPIE and EMAPEC projects inter alia)	TF-Health with other groups (TFIAM/CIAM)	
Notes and recommendations from TFIAM 55 and 56	TFIAM	
Activity report together with TFIAM report; annual meetings of EPCAC	TFIAM/EPCAC	
Perform cost-benefit analysis (CBA) of the scenarios supporting the Gothenburg Protocol review	TFIAM	yes

POLICY

Workplan item	Activity description/objective	Expected outcome/deliverable	Lead body(ies)	Resource requirements and/or funding source
2.1.1	Assessment of emission reduction options for the revision of the Gothenburg Protocol and development of scenarios	Recommendations on new emission reduction commitments for pollutants currently covered by Gothenburg Protocol (type of commitment, ambition level, base and target year, etc)	WGSR, TFIAM, CIAM, TFEIP, CEIP	
2.1.6	Discussions on feasibility and utility of including methane in the revised Protocol	Recommendations submitted to the Executive Body	WGSR, TFIAM, TFEIP, TFTEI, TFRN TFHTAP	
2.1.8	Discuss new flexibilities and explore new approaches for non-Parties to Protocol	Recommendations submitted to the Executive Body	WGSR, TFTEI, TFEIP, TFIAM, TFRN	
2.1.9	Further analysis on introducing a risk-based goal(s) for the ECE region to address air pollution impacts on health and ecosystems	Policy options defined and policy brief paper submitted to the Executive Body	WGSR, TFIAM/CIAM, WGE	
2.1.11	Explore ways to achieve integrated approaches among climate, energy and air policies	Policy paper. Recommendations submitted to the Executive Body	TFHTAP, TFIAM/CIAM, TFTEI, TFRN, WGSR	
<b>Development and promotion of guidance documents</b>				
	Promotion of guidance documents, including those recently adopted, and position papers	Presentation of documents to various fora as appropriate	TFRN, TFIAM, TFTEI	
	Examine the risks of use of ammonia as a fuel	Policy brief or information note presented to WGSR	TFRN, TFTEI, TFIAM	Subject to availability of resources

**OUTREACH & COMMUNICATION**

<b>Workplan item</b>	<b>Activity description/objective</b>	<b>Expected outcome/deliverable</b>	<b>Lead body(ies)</b>	<b>Resource requirements and/or funding source (in US dollars)</b>
<b>5.1 Communication and awareness-raising</b>				
<b>5.1.1</b>	Raise awareness among policymakers on the relation between modelling results and negotiated risk-based goals and/or emission reduction commitments	A scientific report on science-policy interactions - from iterative modelling supported by the policy brief to final negotiation results	TFIAM/CIAM	