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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

Ninth joint session
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Item 5 (c) 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

TFIAM discussed the status of the updated GAINS model and concluded that the model is fit to be used in policy preparations. However, the quality of modelling results remains highly dependent on the quality of data reported by countries (e.g. on emissions, air quality polices adopted and implemented). The GAINS model is more comprehensive than ever. It includes the impacts of climate and energy measures on air quality and can zoom in from the continental to the city level. Urban concentrations of air pollution are to a large extend influenced by sources outside the city, often even from sources in other countries. It is shown that measures are needed at all political levels to meet WHO air quality guideline values everywhere. TFIAM decided to develop and present a number of policy scenarios to the policy bodies of the Air Convention: 1) scenarios aimed at a 50% reduction of air quality related health impacts; 2) scenarios aimed at the protection (of e.g. 30%) of the nitrogen sensitive ecosystems; 3) scenarios that illustrate the impact of successive (staged) sectoral control policies. The need for alternative scenarios will have to be discussed further with policy makers.

TFIAM also discussed national integrated assessment studies. There is an overall consistency with the GAINS analyses. However, it became clear that the inclusion of climate and energy measures in the current policy scenario differs among parties. Several climate and energy measures involve lower emissions of nitrogen oxides and particulate matter. But some measures could lead to an increase in emissions, such as wood burning. The impacts

of emerging measures, such as carbon capture and storage, or the use of hydrogen and ammonia as energy carrier would require additional attention from the integrated assessment community.

Further methodological discussions with the national experts will involve the various ways mortality and morbidity impacts are modelled. Also further discussion is needed on the different ways to include bias corrections in future projections. Bias corrections are currently needed to improve the correlation between modelled and measured air quality at local stations.

The 52nd TFIAM meeting was the last meeting co-chaired by Rob Maas (Netherlands). He has been chair since 1994. After 2013 together with Stefan Åström (Sweden). From 2024 Simone Schucht (France) will co-chair together with Stefan Åström.

I. Introduction

1. This report describes the results of the 52nd session of TFIAM, held in Utrecht the Netherlands from the 24th to the 26th of May 2023. 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. 31 experts participated in Utrecht, and some 20 online. These represented the following Parties to the Convention: Belgium, Croatia, the European Union, Finland, France, Germany, Ireland, the Netherlands, Norway, Italy, Poland, Portugal, Serbia, Spain, Sweden, Switzerland, the United Kingdom of Great Britain and Northern Ireland, and the United States. Other bodies of the Convention represented were 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), and the Integrative Cooperative Program (ICP) on Vegetation. In addition, the Joint Research Centre of the European Commission (JRC), and the European Environment Bureau (EEB) were represented.

3. Mr. Rob Maas (Netherlands) and Mr. Stefan Åström (Sweden) chaired the meeting.

4. Mr. Eduard Dame (Netherlands) welcomed the participants to Utrecht and opened the meeting.

II. News from the convention and objectives of the meeting

5. Mr. Maas presented the purposes of the 52nd TFIAM meeting: to take note of developments under the air convention, discuss scenarios and models that could support further policy development, collect ideas for a guidance document on ‘non-technical measures’, take note of assessments by parties, and approve the TFIAM 2024-2025 work plan. The proposed work plan of the Task Force for 2024-2025 is included in Annex 2. Mr. Maas also reminded the TFIAM of the mandate of TFIAM.

6. TFIAM took note of the conclusions of the Gothenburg Protocol Review Group that more efforts are needed to meet the long-term targets of the Air Convention. Especially NH3 and CH4 require further attention. In addition to technical measures currently considered in IAMs, other types of measures - such as structural and behavioural changes - will be needed, and correspondingly need to be assessed.

7. Mr. Åström presented the recommendations from the Saltsjöbaden VII workshop. The overarching recommendations included the recommendation for all regions to establish a common objective to reduce air quality related health and ecosystem impacts. Cross-cutting recommendations included increased efforts to control methane emissions and study the role of methane as an ozone precursor; more efforts to reduce ammonia emissions; expanded outreach between the Air Convention and other regions, as well as improving communication

activities from the Air Convention to experts within the UN-ECE region. The full advance version of the recommendations can be found on https://www.ivl.se/projektwebbar/saltsjobaden-air-science-and-policy-workshops.html.

8. Mr. Åström continued to present the draft of the TFIAM 2024-2025 work plan. The proposal is to focus on the development of scenarios which can be used by policy decision makers in the follow-up to the review of the Gothenburg protocol. In addition to the proposal, TFIAM expressed interest in having scenarios that clarify ozone effects on agricultural production, effects of non-technical measures, effects of alternative policies for international shipping, variations in how 'net zero' climate policies are implemented. Furthermore, scenario visualisation of how a 'staged approach' to air pollution policy implementation was deemed interesting.

9. France has agreed to take over the responsibility for the role of co-chair from the Netherlands. From 2024, Sweden and France will co-chair TFIAM. TFIAM agreed to request the EMEP Steering Body to include this revision in the formal text of the TFIAM mandate and formally adopt this at the 9th joint meeting of WGE and EMEP-Steering Body. In 2024, Stefan Åström and Simone Schucht will act as co-chairs.

III. Support of further policy development under the convention

10. TFIAM took note of the presentation by the head of the Centre for Integrated Assessment Modelling (CIAM), Zbigniew Klimont. Mr. Klimont presented recent GAINS model development as well as new scenarios that have been implemented in the GAINS model. NOx and VOC emissions from agricultural soil are now included and increase total anthropogenic NMVOC by about 20% and NOx by 15% in the UNECE region. There is, however, a strong regional variability, from about 10% to over 50%, and the share of the agricultural NMVOC and soil NOx is likely to increase in the future. Condensables are also included. Focus was on the scenario work that underpinned the EU Clean Air Outlook 3. The scenarios up to 2050 show that the baseline scenario will lead to large improvements in human health, nevertheless, WHO guideline values for annual average PM2.5 concentrations will still be exceeded in many areas. The European energy system response to the Russian military invasion of Ukraine is likely leading to slightly higher emissions of air pollutants in the next decade compared to the baseline scenario, while in the long term emissions could be even lower. If trying to achieve the WHO guideline values for PM2.5, several pollutants would need to be controlled with all available control technologies. The LOW scenario includes a 15-20% additional reduction of ammonia emissions due to stricter emission limit values for industrial farms, further improvements of nitrogen use efficiency, and impacts of dietary changes. Global methane scenarios show a 30% reduction with available technical measures and 70% when structural and non-technical measures are included.

11. CIAM has also studied achieving alternative versions of a 50% reduction target in human health impacts by 2035. When using 2005 as a base year, most parties in the UN-ECE will have technical capacity to reach a 50% reduction in mortality effects caused by anthropogenic emissions of PM2.5. The Balkan and the EECCA region will likely need more than technically available solutions to reach a 50% reduction.

12. TFIAM concluded that GAINS is fit for supporting policy development, both at the continental and local level. TFIAM recommended to make GAINS model and scenario country data available to national experts for further scrutiny and to analyse national abatement options.

13. TFIAM concluded that to reduce health risks by 50%, additional measures, including structural and behavioural changes are needed especially in Balkan and EECCA countries. Further evaluation of the model assumptions, and further discussion on base year and target year are needed. TFIAM noted that further targets also addressing ecosystem improvements in the long term need to be discussed and assessed.

14. TFIAM also recommended to explore a staged approach in future IAM model scenario analysis. A tentative mode of implementation can be to look at impacts of implementing

regulations for large combustion plants, transport, agricultural, and residential regulation as separate steps.

15. TFIAM took note of the presentation by Michael Holland, vice-chair of EMEP, on recent developments of cost-benefit analysis. Mr. Holland also reported results from the Task Force on Health. Analysis showed that the current EU ambient air quality proposal would lead to a high benefit/cost ratio. New WHO reports on health impact calculation methods are underway (HRAPIE2 on mortality and EMAPEC on morbidity to be available end 2023) that could give guidance to how countries model health impacts from air pollution. Currently up to a factor 4 differences in mortality estimates occur. Based on a German study reasons for discrepancies are the use of different response functions, different population estimates, as well as different exposure estimates. There is currently no empirical basis for moving from the assumption of treating all PM2.5 species the same.

16. The inclusion of morbidity impacts leads to a 33% increase of health damage costs compared to only taking mortality effects into account. The work for the Clean Air Outlook 3, showed the imbalance in studies on morbidity health outcomes that are associated with air pollution. For PM2.5 the literature gives support to quantification and monetary valuation of some 15 health endpoints, whilst for NO2, only 5 health endpoint valuations can be supported, and for ozone only three. There is uncertainty about the degree of possible double counting when quantifying identical health effects from PM2.5 and NO2. A robustness check, comparing results of the cost-benefit analysis when counting (i) only health impacts from PM2.5, (ii) all health impacts from PM2.5 and NO2 showed that the associated uncertainties have limited impact on the total outcome of the benefit/cost ratio of air pollution policy and do not modify its conclusions.

17. TFIAM concluded that the currently best available estimates based on recent TF health results on economic values of health effects show that morbidity impacts would add 33% to the mortality impacts (when valuing mortality with VOLY). Further advice on health impacts will become available by the HRAPIE2 and EMAPEC studies led by WHO.

18. TFIAM noted an imbalance in the number of health effects identified as associated with PM2.5, NO2, and O3. The number of health effects identified for PM2.5 appears higher than for NO2 and O3.

19. TFIAM acknowledged the presentation by Felicity Hayes from ICP Vegetation. Ms. Hayes presented ex-post calculations on ozone damages to vegetation, based on the scenarios produced for the review of the Gothenburg Protocol. The percentage yield losses for wheat are largest in Italy and parts of South-Eastern Europe, with yield losses typically in the range of 12-15%. In Northern Europe and in dry regions, the effect is small. Production losses take into account both the percentage yield loss and wheat production per country. Although losses decrease with increasingly stringent scenarios, even for the most ambitious 2050 scenario total losses from the top 10 wheat producing countries are estimated to be 13.2 million tonnes. There are also significant effects on growth of forests, with growth losses ranging between 20-25% in 2015, and whilst losses reduce in the future scenarios, significant losses remain.

20. TFIAM took note of the presentation by Guus Velders, co-chair of the Expert Panel on Clean Air in Cities (EPCAC). Mr. Velders presented the focus areas of EPCAC. The 4th session of EPCAC 4 was held online in autumn 2022. Its report is included in annex 1. The importance of multi-level governance is widely confirmed as important for air quality in cities. Currently, EPCAC is preparing an informal position paper on the importance of multilevel governance for urban air quality in Europe, including discussions on country-to-city aspects as well as city-to-city aspects of pollution dispersion.

21. TFIAM advised to increase contacts with city representatives and organisations such as Eurocities (The100 Climate-Neutral and Smart Cities by 2030 - Eurocities) and projects such as TAPAS (TAPAS – Tackling air pollution at school – Clean Air Programme (ukcleanair.org). TFIAM also advised to involve developing countries, and to promote the use of citizen science.

22. TFIAM acknowledged the information about the ongoing work of TFHTAP, as presented by the TFHTAP co-chair Tim Butler. Currently, TFHTAP is focusing much on

drivers of ground-level ozone formation. Of the total reduction in peak ozone in Europe, 1/3 would come from reduction in global methane emissions, 1/3 from reduction in European precursor emissions and 1/3 from reduction of precursor emissions outside Europe. Results show that tackling the currently regulated ozone precursor pollutants (NOx and NMVOC) is more important than methane for reducing ground-level ozone formation in the UNECE. However, due to the strong increase in methane emissions worldwide, it is likely that the relative importance of methane will increase, especially for peak-level concentrations. Future work of TFHTAP includes efforts to minimize scientific uncertainty through inter alia multi-model assessment and consistent use of policy-relevant emission scenarios.

23. TFIAM concluded that global emissions of CH4 substantially contribute to ozone pollution in Europe, and its importance is likely to increase in the future.

24. TFIAM concluded that emissions from shipping require attention in hemispheric and other models. New policy initiatives (North Atlantic & Mediterranean emission control areas) and technologies such as the use of NH3 as an energy carrier are discussed and need to be assessed.

25. Mr. Maas presented the ongoing work of developing a guidance document on structural and behavioural change measures to reduce emissions of air pollutants. The guidance document aims to present general considerations for the need of non-technical measures and the available policy instruments to implement them. The document also will include successful examples, estimates of total potential of non-technical measures, as well as recommendations for policy makers and modellers.

26. TFIAM concluded that an NTM guidance document should, in addition to already considered measures, include successful examples on measures that reduce residential wood burning emissions.

27. TFIAM took note of the presentation by Bruce Rolstad Denby from MSC-West on ongoing work with uEMEP to calculate high-resolution air pollution concentrations. Special attention was paid to the bias correction that was needed to improve the correlation between modelled and measured air quality at local stations. Models tend to underestimate the measured concentrations. Average bias corrections were 22% for NO2 and 19% for PM2.5, but differ per country. Bias corrections intend to account for any local scale modelling errors and for deviations in reported emissions. The bias correction factors proved to be constant for the years 2015-2020. The evaluation of the bias correction showed that the method is robust and realistic on a European wide scale, that alternative methods for the use of bias corrections in scenarios give similar results. The bias correction will not change the conclusions from the review of the EU ambient air quality directive regarding exceedance risks and patterns at the overall EU level but can change conclusions for some regions within the EU.

28. TFIAM concluded that the use of the bias correction in air quality modelling differs among countries and asked advice from TFMM.

29. TFIAM took note of the presentation by Gregor Kiesewetter from CIAM on recent GAINS model developments with respect to urban scale air pollution concentration calculations for approximately 1270 cities in the EMEP-region. A change from earlier versions of the GAINS model is the addition of sector-specific pollutant transfer coefficients based on tracking of primary PM from grid to grid in the EMEP model. The tracking calculations are done on a monthly basis to allow for better representation of temporal variation of emissions in certain sectors throughout the year, for example residential heating. The results show regional variations in most important sectors for local PM2.5 concentration. In 2015, transport dominated in Western Europe, whilst residential combustion and power plants dominate in Eastern Europe. In the Netherlands and the UK as well as in other Western European countries, secondary inorganic aerosols (combined from agriculture and transport) dominate.

30. TFIAM noted the presentation on the EU Forum for Air quality Modelling in Europe (FAIRMODE) given by Mr. Enrico Pisoni. FAIRMODE developed a model quality benchmark, that would enable countries to use model calculations in air quality reporting. Experts can use the FAIRMODE model quality interface (MQI) to check the quality of their

modelling applications. Experts can use the FAIRMODE Model Quality Indicator (MQI) to assess their model's quality. Ongoing work includes reviews of emission inventories and their deviations, as well as further developments in the SHERPA model, that now includes more vertical emission layers to better assess sectoral contributions. Further, FAIRMODE is developing checklists to start a harmonisation of measures addressed in local and national air quality management practices.

IV. Progress of assessment modelling by parties

31. TFIAM welcomed the presentation by Andrew Kelly from Ireland on recent studies to include fairness aspects in road transport policies. According to the Long-Term Strategy of the EMEP Steering Body equity issues should be better addressed in cost-benefit studies. A study aimed at developing a regional specific composite index including affordability, accessibility, and mobility enabled to identify spatial variations in transport poverty risks. Transport poverty is not only a rural problem, and the index can help better design policies to alleviate poverty risks. A study on total cost of vehicle ownership showed consistent lower total costs of car ownership for electric vehicles in just a four-year time horizon for a wide range of car types, mileage and discount rates.

32. TFIAM concluded that equity issues and environmental justice will become more prominent and deserve more attention in IAMs. Aspects such as costs, energy poverty, etc. should be analysed.

33. TFIAM also welcomed the presentation by Dan Loughlin of the US Environmental Protection Agency (US EPA) on modelling for the review of the national air quality policies in the United States. The IAM work ongoing at the US EPA focuses on developing decision support tools for projecting emissions of greenhouse gases and air pollutants, impacts of policies (federal, regional, state), as well as assessing potential effects of existing and emerging technologies. The construction of the GLIMPSE scenario builder tool has enabled the easy-access use of GCAM model for studies of policy scenarios related to climate change and air pollution policies. Recent applications include presentation of state-dependent NOx marginal abatement cost options, specification of sector-specific control potential (including end-of-pipe, fuel shifts, and other measures), as well as exploration of how upstream emissions can be included and represented for a more holistic policy design. Modelling has also been done to assess possibilities for states to reach ozone targets.

Feasibility of WHO air quality guideline values and interim targets

34. TFIAM took note of the presentation by Antonio Piersanti on the Italian assessment of the new WHO guideline values for air quality and the comparison with the Italian National Air Pollution Control Programme. The plan "With Additional Measures" would move Italy closer to the WHO guideline values, but would in many places reach air quality levels between 5 and 10 µg/m3 annual average PM2.5 concentrations, the latter being the interim target "4" suggested by the WHO. The situation is better for NO2, where the already planned "With Measures" scenario would imply that a third of the monitoring stations would have NO2 values below WHO guideline values.

35. TFIAM took note of the presentation of Mr. Maas on the ability for the Netherlands to reach ambient air quality in line with the WHO guideline values and the proposal for a revised ambient air quality directive. Exceedances of the proposed air quality limit values will in 2030 be limited to 2% of the kilometre grids. But at the 100m scale about 6000 places were identified along busy roads where people would be exposed to exceedances of the NO2 limit value of 20 µg/m3. The average exposure reduction indicator showed over the period 2020-2030 a 40% reduction for NO2 and some 30% reduction for PM2.5 (compared to the 25% target objective). Proposed measures in the Dutch climate and nitrogen policies can help reduce the 70 000 YOLLs projected in the Netherlands by 2030 by some 10-15 000. Meeting the WHO guideline values still would imply some 40 000 YOLL from air pollution in the Netherlands.

36. TFIAM noted the presentation by Andreas Eisold from Germany on emission scenarios for Germany and their comparison with the scenarios produced for the revision of the ambient air quality directive. The analysis showed slight decreases of PM2.5 concentrations in Germany between 2020 and 2030. By 2030 it is calculated that 9 % of all background measurement sites will be in areas exceeding 10µg/m3 annual average of PM2.5 (respectively 17 % of all stations including traffic-related sites). A simplified approach to assess urban pollution concentrations indicated that stations that currently have NO2 concentrations below 35µg/m³ (annual average) should be able to reach concentrations under 20µg/m³ by 2030. The 25% average exposure reduction obligation (AERO) for the period 2020-2030 may likely not be reached for PM2.5, but will be met for NO2 in most cases.

37. TFIAM noted the presentation by Simone Schucht on the status of the French national air pollution control programme and results of the modelled exceedances of WHO air quality guidelines and of limit and target values of the proposed Ambient Air Quality Directive (AAQD). In 2019, 100% of the urban population was exposed to PM2.5 concentrations above the new WHO air quality guidance value. With current policies the number of local exceedances of limit values of the proposed Ambient Air Quality Directive is expected to decrease sharply between 2018 and 2030, both for NO2 and PM2.5, but some exceedances, especially for NO2, will remain. Exceedances will also decrease, but remain at a higher number in 2030, for the ozone target value. Analysis of air quality impacts of additional measures is ongoing and will be followed by a quantification and monetisation of health and environmental benefits from additional measures.

38. TFIAM welcomed the presentation by Mark Theobald from Spain on the impacts of ammonia mitigation on air quality, deposition and ecosystems in Southwestern Europe. Calculations made for three fertiliser use scenarios showed that ammonia would decrease by more than 50%, in some areas. PM concentrations would also decrease, although to a lesser degree, whilst HNO3 and SO2 concentrations would increase. The relative impact of the scenarios is slightly larger for ‘dry years’. The studied ammonia abatement scenarios also substantially reduce exceedance of nitrogen critical loads, even without livestock changes. However, with the fertilizer measures the exceedance is in 2030 in 30% of the habitat areas are still above critical loads. A dietary change scenario is being developed. A visualisation tool, including impacts on water quality is available at: Impact Visualizer - AgroGreen-SUDOE (agrogreensudoe.org).

39. Michele Arrighini from Italy presented a recent study on low-carbon and air quality efficient plans for the Lombardy region in Italy, using artificial neural networks to calculate air quality indices of emission scenarios for specific areas. The scenarios included more use of renewable energy, energy efficiency improvements in the residential sector, industry, and transport, as well as increased use of electric vehicles in the transport sector. The climate plan of Lombardy includes a large increase in the use of biomethane from agriculture, which in turn includes changes in agricultural practices with low ammonia solutions. A 23% CO2 emission reduction implies air pollution co-benefits of up to 25%, especially for NOx and PM2.5 emissions. When adding a pareto-optimal air quality plan for further emission reductions of especially NMVOC and ammonia, air pollution can be decreased even further. Despite these measures, the part of the Lombardy region that lies within the Po Valley will still in 2030 experience PM2.5 concentrations higher than the proposed EU air quality limit values, due to the high share of secondary inorganic aerosols. The Italian study emphasised that at least for the Po Valley, the bias correction process presented by MSC-W is problematic and suggested to use for specific domains ad hoc modelling applications with suitable scale and temporal resolution, and chemical description.

40. TFIAM concluded from the presentations that several countries (Italy, Netherlands, Germany, and also EMEP-MSC-W) included a different bias correction in their future concentration estimates. TFIAM suggested to discuss this further and ask TFMM for advice.

Linkages with climate policy

41. TFIAM took note of the impact of the Portuguese Carbon Neutrality Roadmap on air quality, as presented by Francesco Ferreira. Through coupled energy system and air pollution

modelling, air pollution trends consistent with the Carbon Neutrality Roadmap could be modelled. NOx-emissions would be reduced by more than 65% between 2015 and 2050. The results show that certain industrial development plans, such as the extension of the pulp and paper industry, would induce an increase in PM2.5 and NMVOC emissions, which counteract the emission reductions in other sectors. Ammonia emission reductions are small. Currently, Portugal is in non-compliance with the NEC Directive and does not have a National Air Quality Control Programme. Work is ongoing to improve this situation.

42. TFIAM took note of the presentations by Helen Apsimon and Huw Woodward from the United Kingdom on the impacts of the net zero carbon plans for air quality. Large co-benefits are expected in terms of NOx and PM emission reductions. Research is ongoing to develop easy to understand impact factors that show which climate measures and sectors will have the highest impact on human health indicators. There are still large uncertainties on hydrogen economy emission factors. The experts from the United Kingdom called for a cooperative effort within the UNECE to jointly develop databases containing best available knowledge on emission factors of emerging climate solution technologies.

43. They also showed how ammonia emissions relate to land-use changes that are envisaged in the net-zero climate policy. After Brexit, new policy schemes have been put in place to replace the CAP system. These schemes aim to pay farmers and land managers to deliver environmental benefits with implications for ammonia emissions, which motivates further studies on potential effects on ammonia and nitrogen deposition over ecosystems. Changes in the agricultural production have been recognised as necessary for the United Kingdom to reach its climate ambitions, with a reduction in livestock production needed to release land for other uses. The current reactive N deposition reduction target onto protected sites is 17% compared to 2016. Best available technology can achieve approximately 22%, but scenarios with reduced livestock production and changes in land-use, as proposed by the Committee on Climate Change to achieve net zero, could potentially give significant additional reductions in nitrogen deposition, reaching up to 40% or more. In addition to how much the deposition is reduced it is also important to consider the spatial pattern, and where emission reductions can have the greatest benefit in reducing deposition below critical loads, to guide policy and environmental schemes for agricultural development

44. Stefan Åström (Sweden) showed how policy choices could shift when the climate impacts of pollutants were monetized and included in the cost-benefit analysis. Typically, abatement of NMVOC and the black carbon part of PM would get a higher priority and SO2 less. Of the PM-measures recommended as priority by the Air Convention, because of their high content of BC, reduction of emissions from the wood-fuelled heating would have the highest benefit-cost ratio. More in-depth earth system modelling and better methane damage costs are needed to reduce inaccuracies in the calculation.

45. TFIAM concluded that national air quality assessments differ in how they include climate and energy plans. Climate measures can still offer significant reductions in NOx and PM emissions, but some climate strategies need further attention from an air pollution perspective.

V. Any other business

46. The current chair of TFTEI, Tiziano Pignatelli, invites TFIAM to participate at the TFTEI in June. TFTEI will be held in Warzaw Poland and online. TFTEI has produced several guidance documents which are of interest for TFIAM. The current collaboration between TFIAM and TFTEI has the form of ‘knowledge sharing’.

47. There is unfortunately no participation of experts from EECCA countries at this TFIAM meeting. More efforts should be spent on ensuring more active participation of experts from EECCA countries.

48. TFIAM was also reminded that there might be opportunities for funding of research via the green bonds that many countries are financing.

49. The Dutch representative Eduard Dame reminded TFIAM of the fourth Clean Air Forum that will take place on 23 November at SS ROTTERDAM in Rotterdam, Netherlands. The link for registration is: https://eucleanairforum.wmhproject.events/

VI. Conclusions

50. TFIAM concluded that GAINS is fit for supporting policy development, both at the continental and local level. TFIAM recommended to make GAINS model and scenario country data available to national experts for further scrutiny and to analyse national abatement options.

51. TFIAM concluded that to reduce health risks by 50%, additional measures, including structural and behavioural changes are needed especially in Balkan and EECCA countries. Further evaluation of the model assumptions, and further discussion on base year and target year are needed.

52. TFIAM also concluded that further targets also addressing ecosystem improvements in the long term need to be discussed and assessed.

53. TFIAM recommended to explore a staged approach in future IAM model scenario analysis. A tentative mode of implementation can be to look at impacts of implementing regulations for large combustion plants, transport, agricultural, and residential regulation as separate steps.

54. TFIAM concluded that the use of the bias correction in air quality modelling differs among countries and asks advice from TFMM.

55. TFIAM concluded that the currently best available estimates based on recent TF health results on economic values of health effects show that morbidity impacts would add 33% to the mortality impacts (when valuing mortality with VOLY). Further advice on health impacts will become available by the HRAPIE2 and EMAPEC studies led by WHO. TFIAM noted an imbalance in the number of health effects identified as associated with PM2.5, NO2, and O3. The number of health effects identified for PM2.5 appears higher than for NO2 and O3.

56. TFIAM concluded that global emissions of CH4 substantially contribute to ozone pollution in Europe, and its importance is likely to increase in the future.

57. TFIAM also concluded that emissions from shipping require attention in hemispheric and other models. New policy initiatives (North Atlantic & Mediterranean emission control areas) and technologies such as the use of NH3 as an energy carrier are discussed and need to be assessed.

58. TFIAM concluded that national air quality assessments differ in how they include climate and energy plans. Climate measures can still offer significant reductions in NOx and PM emissions, but some climate strategies need further attention from an air pollution perspective.

59. TFIAM concluded that an NTM guidance document should, in addition to already considered measures, include successful examples on measures that reduce residential wood burning emissions.

60. TFIAM concluded that equity issues and environmental justice will become more prominent and deserve more attention in IAMs. Aspects such as costs, energy poverty, etc. should be analysed.

Annex 1:

Report of the 4th meeting of the Expert Panel on Clean Air in Cities (EPCAC) held online on Nov. 16, 2022

1. Around 100 participants (140+ registered participants) from national governments, cities, the scientific community, NGO's, industry, and the European Commission participated in a workshop that was held online on November 16, 2022. Roald Wolters (Netherlands) and Guus Velders (Netherlands) chaired the meeting.

2. Poor air quality is at the top of all environmental health impacts in the EU with 300 000 premature deaths annually. With additional social, economic and environmental impacts, such as disproportional effects for vulnerable groups (children, elderly), lost workdays, and eutrophication and acidification of ecosystems. Exposure to air pollution in EU has been reduced over the past years. Currently, the largest exceedances of the WHO (2021) air quality guidelines for the EU urban population comes from for exposure to ozone, followed by PM_{10}, $PM_{2.5}$, and NO_2.

3. Michael Klinkenberg (European Commission) presented the proposal for the revision of the EU Ambient Air Quality Directives. The proposal focusses on:

(a) Environment & health: Zero pollution objective at the latest by 2050 with intermediate 2030 EU air quality standards, an update of other air quality metrics, and a regular review mechanism.

(b) Monitoring & assessment: Refined approach to air quality monitoring and increased use of modelling, and monitoring of pollutants of emerging concern (UFP, BC, ammonia).

(c) Governance & enforcement: Air quality plans to be more effective in ending and preventing exceedances of EU standards, improved enforceability, and more transboundary cooperation on air quality.

(d) Information & communication: More up to date air quality information, hourly reporting of air quality data, and informing the public about possible health impacts and providing recommendations.

4. The commission proposes as interim target for 2030, 10 µg m-3 for $PM_{2.5}$ and 20 µg m-3 for NO_2 (annual averages). This is projected to reduce premature deaths by more than 75% by 2030 (50% than without this policy). The benefits far outweigh the costs: with annual total gross benefits estimated at €42 bn in 2030, compared to measures that costs less than €6 bn annually.

5. Rob Maas (co-chair TFIAM, RIVM) discussed the status of the Gothenburg Protocol review. Two status reports are being produced for the review, in which three scenarios are presented: a Baseline scenario (current policies), a Maximum Technical Feasible Reduction (MTFR) scenario, and a Low scenarios for 2050 (including lower livestock numbers). Data for every 5 years are available. Only with the Low scenario the $PM_{2.5}$ WHO guidelines are met everywhere in the EU, but critical loads for acidification and eutrophication will still be exceeded in several nature areas. The reports will be discussed in December 2022 at the executive body. Items that are being discussed are, among others, how can we tackle methane and what instruments can be used to reduce ammonia emissions?

6. The TFIAM requested EPCAC for a policy brief on multi-level governance by June 2023.

7. Martin Lutz (Senatsverwaltung für Umwelt, Verkehr und Klimaschutz) gave a reflection from Eurocities on the revised EU framework on air quality. The first milestone in 2030 is considered ambitious. It is a good idea to have supersites for monitoring, but not only at background sites, also at hot spots. Eurocities supports that Legally binding limit values will be the key drivers to reduce air pollution in the EU, but it is critical that the role of national regulations is reduced. Most of the $PM_{2.5}$ must be tackled on the EU and national level, because of its large-scale character.

8. Bruce Rolstad Denby (Norwegian Meteorological Institute) discussed whether the WHO air quality guidelines can be attained under a revised Gothenburg Protocol and presented future scenarios for the EU, West Balkans and EECCA countries. Scenario calculations for 2015, 2030, 2050 have been performed with the EMEP/uEMEP models with a focus on NO2 and $PM_{2.5}$ for the Baseline, MTFR, and Low scenarios.

9. Achieving the proposed EU air quality limit values:

(a) 20 µg m-3 for NO_2 is a challenge for 2030 and will likely require additional local measures. Most countries will have achieved it everywhere in 2050.

(b) 10 µg m-3 for $PM_{2.5}$ everywhere is a large challenge in 2030, but possible in 2050. Around half of the countries (16) will have achieved $PM_{2.5}$ concentrations less than 10 µg m-3 everywhere in the 2030 MFTR scenario.

10. Gregor Kiesewetter (IIASA, Laxenburg) discussed the source contributions to city level $PM_{2.5}$ concentrations under future scenarios for Europe and EECCA countries. For this, the domain of the GAINS model was extended covering EECCA countries and the resolution was increased to 0.3 x 0.2 deg. Also, separate reduction for NOx soil emissions was implemented, condensables were included, and grid-to-grid tracking for primary PM contributions was considered. In the EU, strong decreases of ambient PM concentrations in cities are expected by 2030 with current legislation (local measures were not considered). Secondary organics and inorganics have a significant contribution to PM concentrations in cities. In West Balkan and EECCA countries, residential emissions and power/heating plants dominate PM concentrations; local contributions are often higher than in Western Europe. Current legislation reduced concentrations, but there is scope for significant further reduction.

11. Xavier Querol (Institute of Environmental Assessment and Water Research, IDAEA-CSIC, Barcelona) showed levels and patterns of UFP and BC in urban Europe from the RI-URBANS project. Large difference were observed in UFP particle number concentrations between street locations, urban background, and regional background, with an increasing trend from North to South Europe. Large contributions are from airports and from coal fired powerplants (linked to SO2 emissions). There are also large differences between cities in Europe. It is important for the assessment of UFP, to harmonize the measurement methods.

12. Hanna Boogaard (Health Effects Institute, Boston) presented the results of a new systematic review of selected health effects of long-term exposure to traffic-related air pollution. The review included a full text read of about 1100 articles and about 350 articles were used in the final selection. Apart from exhaust emissions, attention was also paid to non-exhaust emissions and noise effects of traffic. The study finds an overall high or moderate-to-high level of confidence in an association between long-term exposure to traffic related air pollution and the adverse health outcomes: all-cause, circulatory and ischemic heart disease mortality, lung cancer mortality, asthma onset in children and adults, and acute lower respiratory infections in children. In light of the large number of people exposed, the findings indicate that traffic-related air pollution remains an important public health concern and deserves greater attention from the public and from policymakers.

13. Sasha Khomenko (Barcelona Institute for Global Health, ISGlobal) talked about a SHERPA modelling study on the spatial and sector-specific contributions to ambient air pollution and mortality in European cities. She concluded that the residential and agriculture sectors are the main contributors to $PM_{2.5}$-related mortality in European cities and that transport is the main contributor to NO_2-related mortality. The city contribution to air pollution mortality is 13% for $PM_{2.5}$ and 34% for NO_2, and higher for cities of largest area and among European capitals (22-30% for $PM_{2.5}$ and 52-63% for NO2). Strong variability between cities and a higher variety of sources for $PM_{2.5}$ than for NO2 show the need of city specific policies and coordinate actions at multiple spatial levels (city, country, international).

14. Claudio Belis and Rita van Dingenen (EC, Joint Research Centre) presented the results of a study on the air pollution health impacts and cost estimation in Western Balkans' cities. They found that in 2019, the average mortality rate in Western Balkan cities was twice the average value in EU27. The external cost due to air pollution in the 33 studied cities was above 5 billion Euro with an average cost per city of at least 200 Million Euro (only

mortality). The highest (absolute) impacts were observed in Serbia and Bosnia and Herzegovina. The relative impact of road transport in the Western Balkan was higher in the southern part of the region (Albania, Kosovo) and on average lower than EU27. Data from local networks was important to improve the data coverage and there is a need to improve the monitoring strategy in this area to reduce the uncertainty in the estimates.

15. Two presentations were given on the health impacts of specific PM species. It was concluded that at present $PM_{2.5}$ remains the most suitable metric for air pollution related health effects.

16. Michael Holland (EMRC) gave a presentation on an health impact assessment of specific PM species and the relation with NO_2. The current approach is to treat each particle as equally harmful per unit mass, although the different PM fractions (metals, organics, inorganics, size fractions) have a different toxicity. The health effects of each fraction are hard to disentangle. More studies are needed to be able to do this, but that takes time. The question is: What is the pollution and policy situation in the future and what information do we need by then.

17. David Segersson (Swedish Meteorological and Hydrological Institute) asked if we should use separate risk functions for near-source and long-range PM. Increased mortality from PM in Stockholm and Gothenburg is mainly caused by long range transport. Using different relative risks for near source and long-range exposure, local sources become more important. Not using relative risks based on "within city" contrasts in exposure, likely leads to an underestimation of effects from local measures. Application of relative risks recommended by WHO may be misleading when comparing different abatement strategies. For example, if exhaust PM emissions are assumed more toxic than non-exhaust PM, relative risks using Black carbon as indicator are preferable, since it is less diluted by non-exhaust PM and more dominated by vehicle exhaust.

18. Positive actions to improve the air quality have been demonstrated for several cities and countries. These can serve as examples for other cities and regions. It was demonstrated that attention for communication and raising awareness of the local air quality is important. These are also several initiatives in cities to engage citizens.

19. Lara Aleluia Reis (RFF-CMCC European Institute on Economics and the Environment) showed the contribution of agriculture to the PM pollution in Lombardy based on analyzing data measured with machine learning techniques for the COVID19 lockdown. In rural areas the secondary inorganic aerosol (SIA) in Lombardy remained insensitive to the lockdown, showing that in these sites air pollution policies need to target livestock emissions. In traffic areas, the ammonia reductions (probably from traffic too) were instrumental in decreasing SIA. It is estimated that on average a 1% increase in cattle livestock intensity translates into an 1.8% increase in ammonia concentrations (up to 0.4 PM10 µg m-3).

20. Joanna Strużewska (Institute of Environmental Protection - National Research Institute, IEP -NRI) studied the impact of traffic emissions on air quality in Warsaw using measurements and the SHERPA model. Local observational data is analysed to assess traffic intensity. Estimated emission intensity differs from the profiles used so far in the model simulations. Data variability suggests that in the case of NO_2 concentrations follow traffic intensity estimates, but for PM_{10} the pattern may suggest that resuspension plays major role. For $PM_{2.5}$ the difference between traffic and urban background stations is relatively small. This may suggest that emissions from transport sector do not play a major role and the inventory may be overestimated for $PM_{2.5}$.

21. Paul Ruyssenaars (RIVM, Netherlands) presented the air quality plans and progress in the Netherlands and the attainability of 2021 WHO air quality guidelines. The health impacts of air pollution are the motivation for air quality policies by local governments. The goal is a reduction of 50% in loss of life expectancy in 2030, relative to 2016. Multilevel governance is necessary for achieving the health objectives (both for efficiency and equity perspective). Also, integrating policies is important; nitrogen and climate policies are helpful for the air quality objectives, while the air quality objectives are also relevant for climate policies. Large reductions in emissions of NOx and ammonia are required in the Netherlands, but also in neighbouring countries. The WHO (2021) air quality guidelines are demanding for 2030; under interim target 4 some hotspots remain in the country.

22. Núria Castell (NILU – Norwegian Institute for Air Research) showed the importance of citizen science for cleaner air and healthier cities. Citizen science is a powerful research and policy-making approach in support of cleaner air, providing data, awareness, and actions. It is important to integrate citizen science in research and governance to achieve the zero pollution goals.

23. Mark Barrett (UCL Energy Institute) discussed modelling the effect of low carbon energy strategies on city air pollution. Renewable electricity (except biomass) and electrification are a general solution to reduce NO_2 concentrations on city and larger scales, and reduce greenhouse gas emissions. This requires city and (inter)national policy. PM is heterogeneous and primary PM from natural sources and non-exhaust vehicle and secondary PM from ammonia are hard to control.

24. Young Sunwoo (International Union of Air Pollution Prevention & Environmental Protection Associations, IUAPPA) informed the meeting of the international cooperation in East Asia, in the past, present and future. Air quality in Seoul has improved over the past years. High concentrations depend on overseas contributions and meteorology (stagnant days). International cooperation is therefore important and a range of institutions are in place, but the collaboration between countries is a challenge. The lessons learned in the CLTAP could be valuable for the region.

25. Chris Dore (AETHER) assessed the air quality in Bishkek (Kyrgyzstan). Bishkek is sometimes the most polluted city in the world, due to residential coal use, old road vehicles, mountainous terrain, and strong winter-time inversions. Limited information is available to support air quality policies. A start is made on building evidence base recommendations for future investments, recommendations to update air quality legislation, and explaining some fundamentals of air quality management to local counterparts. Clear communication and interaction with local policymakers is important. Cooperation with international organizations is setup for coordination of technical and donor meetings, and the generation of emission maps and modelling.

Conclusions

- Poor air quality is at the top of all environmental health impacts in the EU with 300 000 premature deaths annually. Additionally, there are social, economic and environmental impacts, such as disproportional effects for vulnerable groups, loss of workdays, and eutrophication and acidification of ecosystems. Although air quality in Europe has improved since the 1980s and the EU air quality limit values are met in many countries, meeting the WHO (2021) air quality guideline levels requires large additional reductions in emissions of most air pollutants in many countries.
- The link between air pollution and health effects is reinforced by several (review) studies. Although different PM fractions have a different toxicity, total PM2.5 remains the most used metric for air pollution related health effects.
- In 2022, the European Commission published a proposal for the revision of the EU ambient air quality directive. The objective is zero pollution no later than 2050 with interim targets for 2030: 10 µg m-3 for PM2.5 and 20 µg m-3 for NO2 (annual averages). This is projected to reduce premature deaths by more than 75% by 2030 (while 50% reduction would be reached without this policy). The proposal also includes a regular review mechanism, a refined approach to air quality monitoring, monitoring of pollutants of emerging concern, improved enforceability, and communication of more up to date air quality information.
- The proposed EU air quality limit value for NO2 in the EU is a challenge and will likely require additional local measures, next to national and international measures that need to be taken. The expectation is that most countries will be able to achieve it everywhere in 2050, when implementing EU-emission limit values and net-zero carbon policies. To meet the limit value for PM2.5 everywhere in 2030 is a large challenge, but possible for 2050, when ammonia emissions are further reduced with lower livestock numbers.

- Measurements and modelling studies show that a range of different sectors contribute to air pollution, such as traffic, industry, residential heating, and agriculture. These sectors contribute differently to the air pollution in different cities in the EU, West Balkans, and EECCA countries. Local urban sources from traffic and residential heating contribute most to the NO2 pollution in large cities, while industrial and agricultural sources from outside the city contribute most to PM10 and PM2.5. Models provide the necessary information for local and national authorities for decisions related to air quality in combination with other policies, such as spatial planning, energy, and climate policies.

- Multilevel governance is necessary for achieving the health objectives (both from an efficiency and an equity perspective). Also, integrating policies is important; nitrogen and climate policies are important to meet air quality objectives, while the air quality objectives are also relevant for climate policies.

- Positive actions to improve the air quality have been demonstrated for several cities and countries. These can serve as examples for other cities and regions. It was demonstrated that attention for communication and raising awareness of the local air quality is important. Citizen science is a powerful research and policy-making approach in support of cleaner air providing data, awareness, and actions. It is important to integrate citizen science in research and governance to achieve the zero pollution goals.

Annex 2:

Proposed TFIAM-CIAM workplan 2024-2025

1. TFIAM will continue to integrate knowledge from science bodies in an integrated assessment framework to support the policy process with scenario analyses (see point 5).

2. CIAM will continue to update and further develop the GAINS model. New scientific findings, e.g. on the condensable fraction of the particulate matter emitted from various sources, on the emissions of soil NOx and NMVOC from agricultural sources (livestock and crops), or on the implications of hydrogen economy on emissions of GHGs and air pollutants will be included. Moreover, the GAINS model will be refined to enable the assessment of health risks for the urban population, and provide an updated assessment of emissions and projections of mercury at a global level.

3. At the request of the policy bodies TFIAM produces special reports. In 2024 TFIAM will finalize a guidance document on non-technical measures and policy instruments. The Expert Panel on Clean Air in Cities (a subsidiary body of TFIAM) will submit a guidance document on tools and experiences to improve urban air quality. If requested, further work on the linkages with climate and biodiversity measures or on equity aspects of policy strategies might be included in the work program for 2025.

4. TFIAM will also continue to stimulate national integrated assessment capacity and to exchange experiences with national experts. The challenge is to involve experts from EECCA, Türkiye and West Balkan. For this group CIAM will organize a workshop on GAINS scenarios at IIASA and pursue further exchange with national experts. TFIAM/CIAM are ready to contribute to targeted webinars to be organized by TF FICAP.

5. No clear scenario requests from the policy bodies have been received yet. Until such requests arrive, CIAM will explore illustrative scenarios in between the CLE-scenario and MFR/LOW, focused on reduction targets for health impacts and/or on the reduction of exceedances of nitrogen critical loads. CIAM will update the potential for hemispheric methane mitigation. In cooperation with MSC-W and TF HTAP the effectiveness of hemispheric methane measures will be explored for reducing ground level ozone in the UNECE.

6. France has agreed to take over the responsibility for the role of co-chair from the Netherlands. From 2024, Sweden and France will co-chair TFIAM. This revision should be included in the formal text of the TFIAM mandate that is to be adopted at the 9th joint meeting of WGE and EMEP-Steering Body. In 2024, Stefan Åström and Simone Schucht will act as co-chairs.

Overview of the TFIAM-CIAM workplan 2024-2025

Science

Workplan item	*Activity description/ objective*	*Expected outcome/ deliverable*	*Lead body(ies)*	*Resource requirements and/or funding source*
Integrated assessment tools				
x.x.x.x	Stimulate national integrated assessment capacity and exchange experiences	Notes and recommendations from TFIAM 53 & 54	TFIAM	Covered by national contributions
z.z.z.z	Integrate knowledge from science bodies in an integrated assessment framework and support the policy process with scenario analyses.	Specification of ‘optimized scenarios’, ‘optimized & equity scen.’, ‘ozone precursor scenarios’, ‘health in cities scenarios (including agricultural effects)’, ‘net-zero climate scenarios’, ‘staged approach scenarios’.	CIAM, MSC-West, TFHTAP, TFIAM	
b.b.b.b	Support policy process with scenario analyses.	Calculation and analysis of scenarios	CIAM, MSC-West, TFHTAP, TFIAM	
Linking the scales				
x.x.x.x	EPCAC activities	Activity report together with TFIAM report Annual meetings of EPCAC 5 & 6	TFIAM with nominated experts	Covered by in-kind contributions from participating countries
Cooperation with parties				
y.y.y.y	Regular coordination with task forces and expert groups on Methane, ozone, nitrogen	Meeting notes	TFIAM, TFHTAP, TF-Health, TFRN, FICAP	
d.d.d.d	GAINS model workshop for EECCA, SW Balkan, Türkiye	Workshop report	CIAM	
Cooperation with other projects and bodies (outreach activities)				
c.c.c.c	Promotion of guidance documents, including those recently adopted	Explore opportunities to promote guidance documents, including those recently adopted within and outside ECE	TFIAM	

Policy

Workplan item	*Activity description/ objective*	*Expected outcome/ deliverable*	*Lead body(ies)*	*Resource requirements and/or funding source*
Development and promotion of guidance documents				

Workplan item	*Activity description/ objective*	*Expected outcome/ deliverable*	*Lead body(ies)*	*Resource requirements and/or funding source*
a.a.a.a	Development of a Guidance document on non-technical and structural measures	Guidance document submitted for adoption by the Executive Body at its forty-fourth session	TFIAM, TFRN, TFTEI	
c.c.c.c	Promotion of guidance documents, including those recently adopted	Explore opportunities to promote guidance documents, including those recently adopted within and outside ECE	TFIAM	