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

Working Group on Strategies and Review

Geneva, 27–31 May 2024
Item 2 of the provisional agenda
Progress in the implementation of the 2024–2025 workplan

Draft policy brief on potential targets to reduce risks for health and ecosystems

Summary

At its sixty-first session (Geneva, 4–6 September 2023), the Working Group on Strategies and Review took note of the information presented by the Task Force on Integrated Assessment Modelling and the EMEP Centre for Integrated Assessment Modelling on the feasibility of introducing a risk-based overarching goal for the Convention, particularly a health damage reduction target. The Working Group requested to provide a policy brief on the potential implications of introducing collective risk-based targets for the UNECE region to address air pollution impacts on health and ecosystems (work plan item 2.1.12). The present informal document provides a draft version of this policy brief. The document focusses on the attainability of an illustrative 50% reduction target of health risks due to exposure to particulate matter and ozone, as well as for the risk of biodiversity loss. The Parties were invited to take note of the results and send comments. This and discussions within the Task Force and with experts from the Working Group on Effects have led to this revised version for the sixty-second session of the Working Group on Strategies and Review. Further discussion within the Working Group on Strategies and Review would be required to decide about the desired risk reduction percentages for health and biodiversity, the choice of the base year and target years they apply to, whether the risk reduction percentage should apply to the UNECE as a whole or to countries individually and whether flexibilities are allowed for EECCA countries. Choices made in this policy brief are arbitrary and meant to be illustrative to explain the various approaches for target setting when discussing a revised protocol. Furthermore, preliminary choices have been made on the metrics to define health and biodiversity risks and to apply them only to the anthropogenic part of air pollution.

Preliminary version

TFIAM/CIAM

Policy brief on potential targets to reduce risks for health and ecosystems

Draft document prepared by the Task Force on Integrated Assessment Modelling and the Centre for Integrated Assessment Modelling, revised version 21 April 2024

I. Introduction

1. This report describes policy scenarios up to 2050, as calculated with GAINS for the UNECE region, including EECCA-countries (Kazakhstan, Kyrgyzstan, Uzbekistan, Turkmenistan, Tajikistan) and West-Balkan countries. The scenarios cover options to address particulate matter and ozone precursors, including methane and the potential policy targets that would be attainable.
2. Improvements in the GAINS and EMEP model include local scale modelling, health impacts assessment methods, soil NO_x emissions inclusion and a consistent representation of the condensable fraction of PM from residential heating. GAINS has been prepared to assess the sensitivity of results for sectoral policies (and ‘staged approaches’). The scenarios cover the whole UNECE region, excluding North America, unless indicated otherwise.

II. Policy scenarios

3. Three scenarios were developed by the Centre for Integrated Assessment Modelling (CIAM):
   a. A baseline scenario, considering trends and policies included in established national air pollution control programs and, for the EU, the European Green Deal including the ‘Fit for 55’ legislation package. For countries without such plans, IEA and FAO projections were used. The baseline includes air pollutants (SO_2, NO_X, $PM_{2.5}$, NH_3, NMVOC, as well as Black Carbon) and methane emissions up to 2050. The baseline assumes effective implementation of current legislation (CLE) and policy plans. This is not self-evident as in the past year several plans have been revised because of geopolitical developments, energy security issues and farmers’ protests. A new baseline scenario is being developed that considers less strict ammonia emission standards for intensive farming in the EU and more decarbonization in West Balkan countries. Bilateral consultations between CIAM and most of the countries to improve the baseline data are ongoing. A new baseline will become available this summer. Until then the baseline developed for the Gothenburg Protocol Review will still be used.
   b. A maximum technically feasible reductions (MTFR) scenario uses the same activity data as the baseline and includes implementation of technologies with lowest emission factors in the GAINS model database. These control options include measures to reduce ammonia emissions from agriculture, measures to reduce $PM_{2.5}$ and non-methane volatile organic compounds (NMVOC) emissions from residential solid fuel burning and agricultural waste burning, mitigation technologies to reduce emissions of sulfur dioxide (SO_2), nitrogen oxides (NO_x), and $PM_{2.5}$ for industrial combustion, process and transportation sources, measures to reduce NMVOC from solvent use, and liquid fuels’ storage and distribution, as well as measures to reduce methane (CH_4) emissions from municipal waste treatment, the fossil fuel sector and agriculture. Maritime emission control areas or initiatives by port authorities are assumed to encourage clean ships and to provide shore-to-ship electricity access. The MTFR scenario uses information about the age structure of installations. Early shutdown or scrapping of cars or boilers is not assumed. Consequently, the mitigation potential increases towards 2050.
   c. An alternative ‘LOW’ scenario, that includes climate policies compatible with the two-degrees Paris Agreement goal for the whole world, MTFR measures (also for maritime shipping), and further transformational changes in agriculture. For agriculture, this scenario is based on the 'Growing Better report 2019[1] (The Food and Land Use Coalition, 2019) and other studies considering ambitious improvements of nitrogen use efficiency (Kanter et al., 2020)[2] and assumes the adoption of a diet based on total human energy requirements of 2500 kcal/day (after waste) as

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[1] https://www.foodandlandusecoalition.org/global-report/.

[2] Kanter, D., Winiwarter, W., Bodirsky, B., Bouwman, L., Boyer, K., 2020. Nitrogen futures in the shared socioeconomic pathways. Glob. Environ. Change 13 2003 277–29361. https://doi.org/DOI:10.1016/j.gloenvcha.2019.102029.

laid out in the EAT-Lancet Commission proposal (Willet et al., 2019)[3]. The latter results in dietary shift towards lower meat protein consumption. The scenario is also consistent with the 30% methane pledge. After the summer an alternative LOW+ scenario will become available that includes structural changes in energy systems, such as a shift towards the use of hydrogen and ammonia as energy carriers.

4. The baseline scenario shows strong reductions of air pollutants between 2005 and 2030 (SO_2: -80%, NO_x: -50 *to* -80%, $PM_{2.5}$: -25 *to* -70%) in the EU, North America, and in West Balkan countries (owing to the Energy Community agreements that include commitments to strong reduction of emissions from stationary sources in the coming decades). Fossil fuel use in EECCA countries continues to grow, however, due to ongoing technical progress, emissions of SO_2 and NO_x are expected to be reduced over time, by approximately 40% and 20%, respectively, between 2005 and 2030. For NH_3, current abatement policies are modest, and the estimated reductions, if any, are mainly due to projected decline in livestock numbers in some regions.

5. The MTFR scenario shows that for SO_2 most of further mitigation potential is committed in the current legislation, except for EECCA. The picture for NO_x is similar, although further potential is available. For NH_3, the mitigation potential is similar across all regions, however, compared to the baseline, the overall potential is smaller than that for other air pollutants. Large further mitigation exists for $PM_{2.5}$, except for the EU+EFTA region, especially in EECCA and West Balkan. The LOW scenario shows that strong climate action brings additional air pollutant reduction although it is most significant for NH_3 and CH_4 (the latter not shown) and this is in fact due to modelled dietary changes and strong improvements of nitrogen use efficiency in agriculture.

6. Analyses done for West Balkan and EECCA shows that the local contribution of residential combustion is dominating particulate matter concentrations in many cities. The power sector is an important regional source. In West Balkan, local residential heating sources cause 50% or more of the concentrations. Even in cases where the baseline brings reductions, the future levels of pollution remain well above the WHO guidelines. This points to the need to develop further mitigation strategies that address both local, regional and transboundary sources to achieve significant reductions of the impact of air pollution in cities in the future.

7. Methane declines in the baseline only in the EU (due to the Green Deal). This contributes to a 7% methane emission reduction in the UNECE region (excluding North America) between 2015 and 2050. In the rest of the world an emission increase of 33% is expected, associated with the growth of the fossil fuel sector. There is a significant technical emission reduction potential, especially with measures in the fossil fuel and waste sector. This could result in a 63% reduction in the UNECE (excluding North America) and of 33% reduction in the rest of the world between 2015 and 2050. Combined with dietary change, the LOW scenario could reach a reduction of 77% in the UNECE and of 40-45% in the rest of the world.

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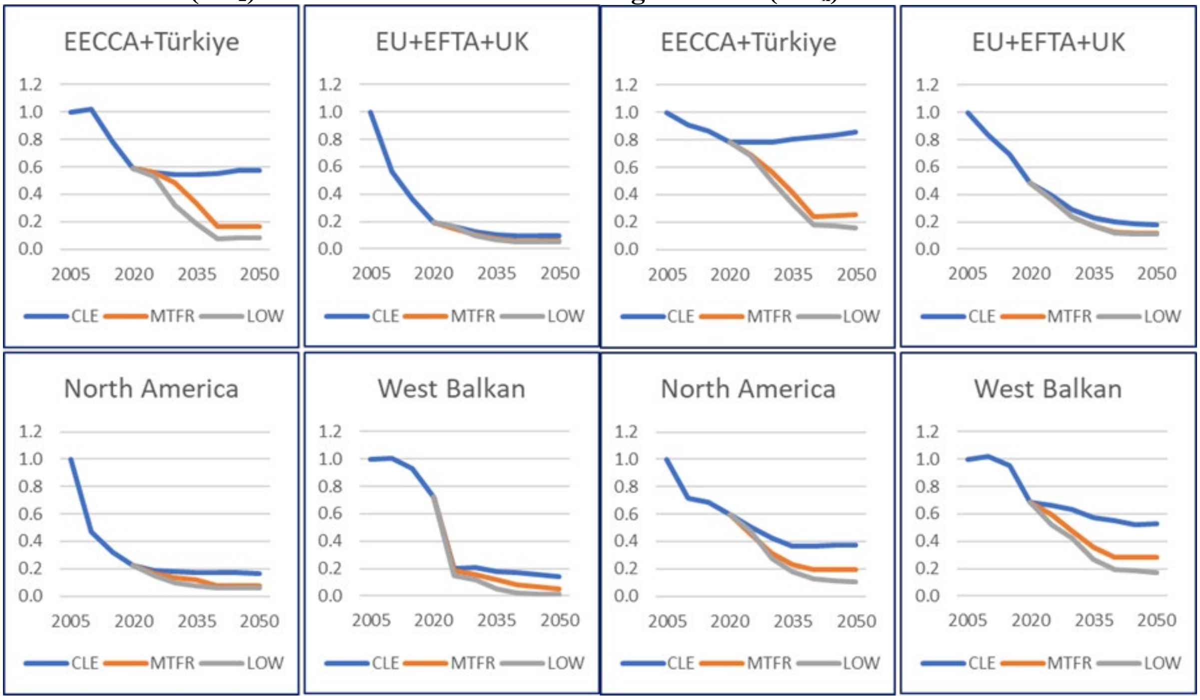
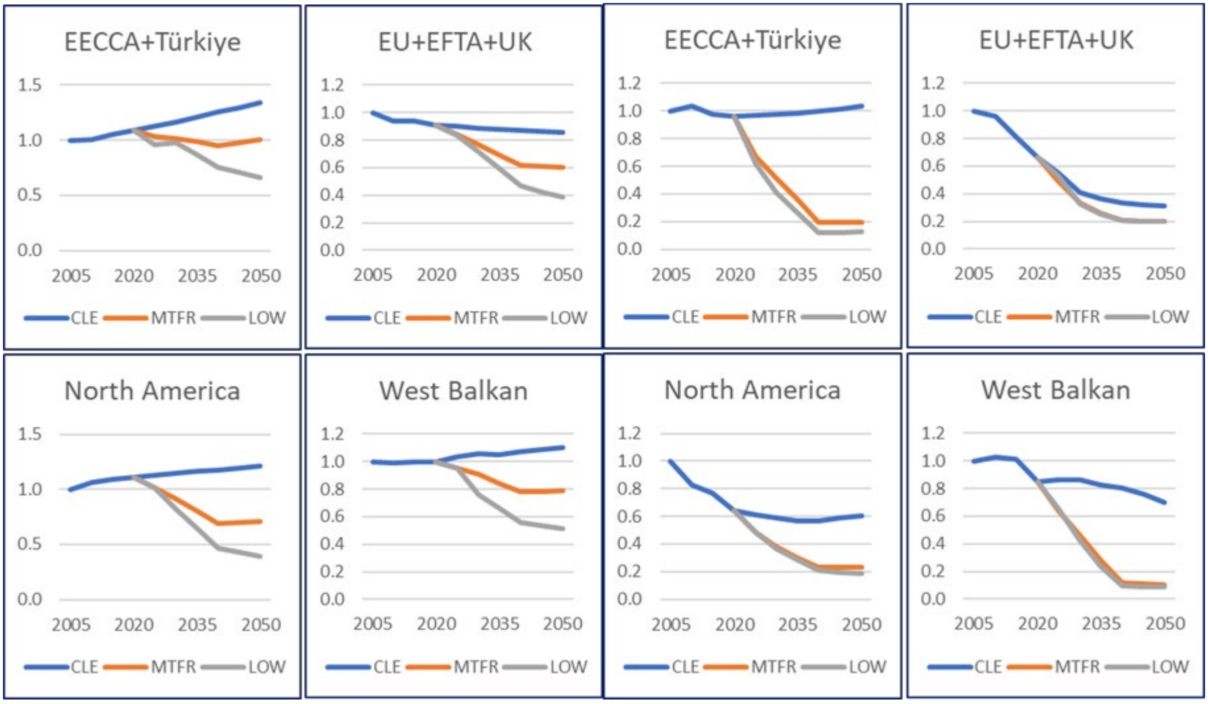
[3] Willet *et al.* (2019) Food in the Anthropocene: the EAT-*Lancet* Commission on healthy diets from sustainable food systems. https://doi.org/10.1016/S0140-6736(18)31788-4.

Figure 1: Emission trends in baseline (CLE), MTFR, and LOW scenario

Sulfur dioxide (SO_2) **Nitrogen oxides (NO_x)**



Ammonia (NH_3) **Particulate matter ($PM_{2.5}$)**

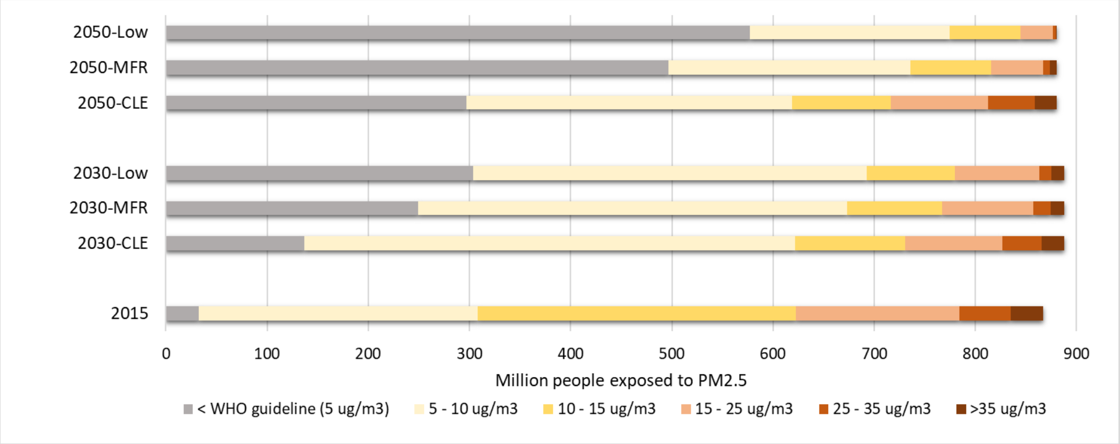


III. Impacts for health and ecosystems

8. Calculations with the GAINS model show that most of the population in the UNECE domain (excl. North America) lives in areas where $PM_{2.5}$ is above the current WHO annual mean guideline value of 5 µg/m^3. The baseline scenario causes declining concentrations in the EU. The current EU limit value (25 µg/m^3) will be met in 2030. Still elevated concentrations persist in Balkan and EECCA countries (see figure 2). Overall levels in large parts of the EMEP domain remain above the WHO guideline in 2030. The MTFR scenario for 2030 does not bring a lot of improvement in the number of people exposed to exceedances of the WHO

guideline, although the concentrations and associated health impacts drop. Both MTFR and LOW are not yet fully effective in 2030 due to the short time available for full introduction of abatement measures or transformations embedded in the LOW scenario.

Figure 2: Population exposure to $PM_{2.5}$ in the UNECE (excluding North America)

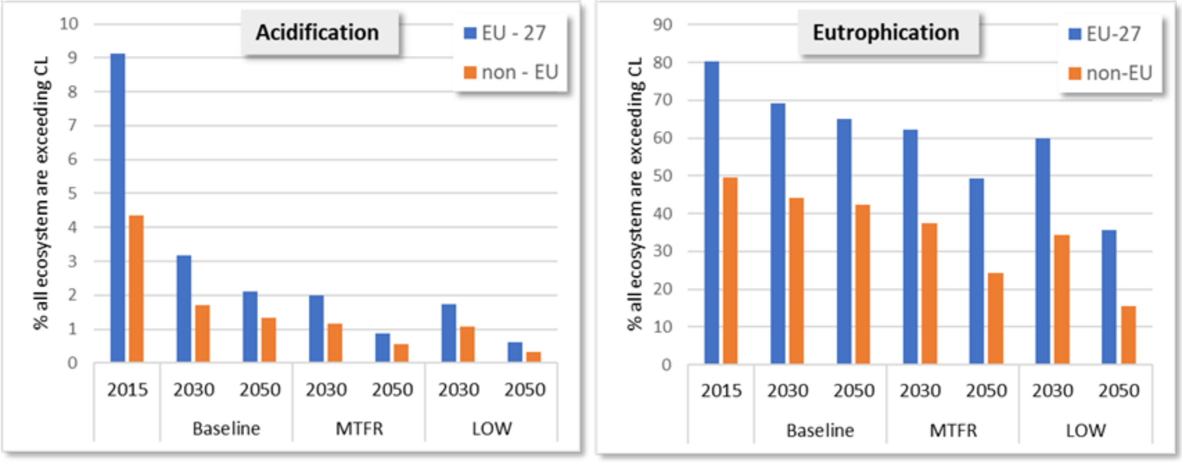


9. The baseline for 2050 shows further improvements, yet the WHO guideline level would only be attained for 1/3 of the population. MTFR brings large scale improvements, also across the Balkan, as there is enough time to introduce further technical measures. Finally, the LOW scenario gives even lower concentrations. A little more than 10% of the population in the UNECE (excluding North America) would still be exposed to more than 10 µg/m^3. However, more than 60% would be exposed to $PM_{2.5}$ levels below the WHO guideline by 2050 (over 80% in the EU+EFTA+UK, 30% in EECCA + Türkiye).

10. For the EU, the exceedance of the critical loads for acidification will be reduced in the baseline scenario from about 9% of all ecosystems in 2015 to 3% in 2030 and 2% in 2050. In the LOW scenario, the exceedance in the EU could drop to below 1% of the ecosystems by 2050. For non-EU countries in the EMEP domain, the exceedance will decline from about 4% of the ecosystems in 2015 to 2% in the 2050 baseline and less than 0.5% in the LOW scenario.

11. The exceedance of the critical loads for eutrophication in the EU will be reduced in the baseline scenario from 80% of all ecosystems in 2015 to 70% in 2030 and 65% in 2050. In the LOW scenario, the area with exceedances could be more than 50% less than in 2015, but 35% of the ecosystems in the EU will remain with an exceedance, even in 2050. For non-EU countries in the European EMEP domain, the exceedance will decline from 50% of the ecosystems in 2015 to around 43% in the 2050 baseline and to 15% in the LOW scenario.

Figure 3: Area with exceedance of critical loads for acidification and eutrophication in Europe. Non-EU includes West Balkan, UK, Iceland, Norway, Switzerland, Belarus, Ukraine, Moldova, European part of Russia up to 42°E.



IV. Options for policy targets

12. One of the Saltsjöbaden VII workshop recommendations is to formulate a common target for air pollution related health risks.[4] Halving the pollution related mortality was suggested. Could this be feasible for the UNECE-region? Can the target be the same for all parties? Can a target be applied to $PM_{2.5}$ related mortality only, or also to mortality due to other pollutants, such as ozone? Should the target focus on mortality, or could it also include morbidity?

13. Several factors influence the attainability of a 50% reduction target:

    a) What is the base year and what is the target year? If reliable data are available, 2005 as base year will for several countries make attainability easier than more recent years, as improvements after 2005 can be considered. For EU and EFTA, the target would already be met without additional policy measures. For several of the current non-parties, however, reliable data is unavailable for 2005. Naturally, the choice of the target year also influences the attainability.
    b) Should the target be applied to the UNECE or to each country (or even each city)? Obviously, it is easier to meet the target for a larger area than for each densely populated area.
    c) An important factor is the definition of the indicator: do we want to halve the absolute number of attributable deaths? Or do we want to halve the attributable mortality (i.e. deaths per 100.000 inhabitants)? The absolute number will be influenced by population growth between 2005 and 2050, which makes it harder to meet the 50% target. However, both indicators are influenced by aging of the population if we do not keep population fixed at the base year.
    d) Should the target be formulated for $PM_{2.5}$ only, or for the combined effect of air pollutants? Inclusion of ozone would make attainability harder due to the increasing emissions of ozone precursors, such as methane.
    e) The choice of the health impact assessment method will also influence the attainability. Do we want to include the risks of natural PM, or focus the target on the avoidable (anthropogenic) PM-exposure? The implications of adding morbidity for the attainability of a 50% reduction target would require further analysis.

14. Figure 4 shows the scope for reducing the average exposure to anthropogenic $PM_{2.5}$ in the UNECE as a whole, as estimated with the GAINS model. In the baseline scenario a reduction of 50% compared to the 2005 level can already be met in 2030. A 50% reduction compared to the 2015 level would require additional efforts.

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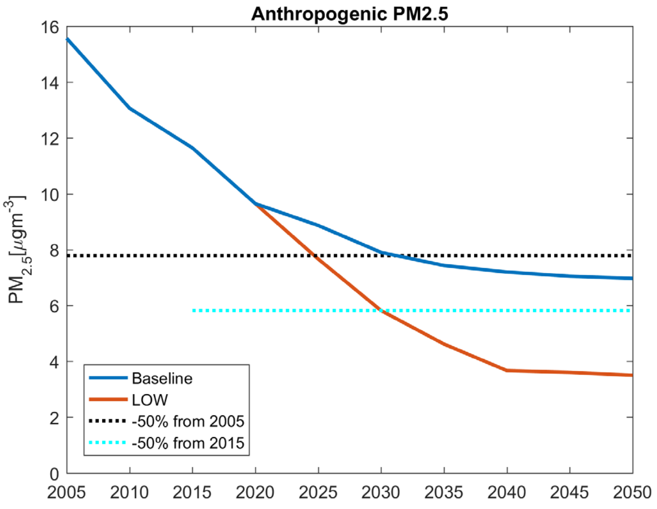
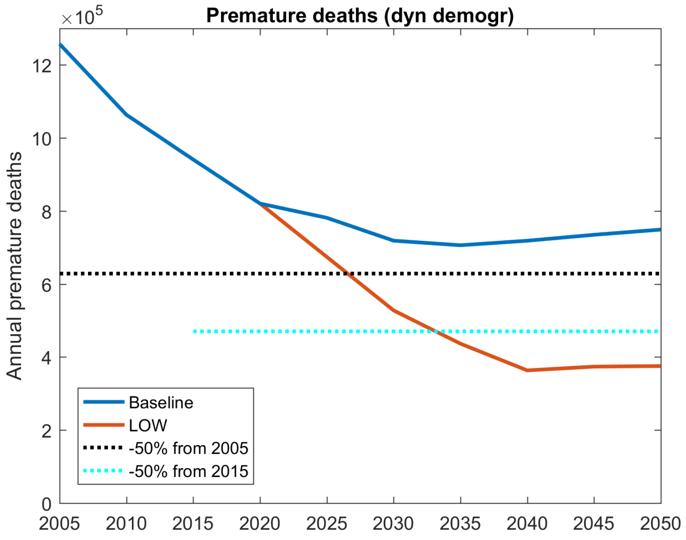
[4] https://norden.diva-portal.org/smash/get/diva2:1796554/FULLTEXT01.pdf

Figure 4: Average exposure to anthropogenic $PM_{2.5}$ in the UNECE-region (incl. North America)



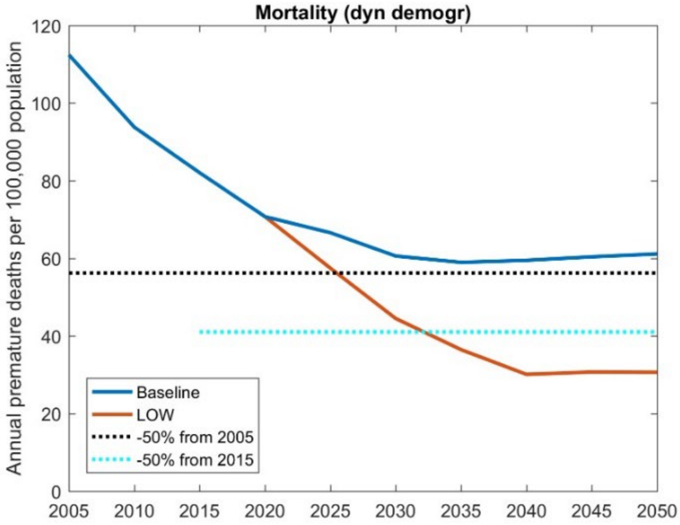
15. In figure 5 the absolute number of premature deaths attributable to anthropogenic $PM_{2.5}$ exposure is shown. Due to population increase and aging, absolute numbers tend to increase, especially in EECCA countries, Türkiye and North America. This makes it impossible to meet the 50% target with baseline policies. Annex 1 shows the differences in the attainability of a 50% reduction for absolute numbers of premature deaths across the UNECE region, largely due to different population dynamics.

Figure 5: Absolute numbers of annual premature deaths due to anthropogenic $PM_{2.5}$ exposure in the UNECE-region (incl. North America)



16. The health risk indicator (premature deaths per 100.000 inhabitants) shows that a 50% reduction target (from the 2005 level) can almost (but not completely) be reached with existing baseline policies (see figure 6). This risk approach would make the health target easier to attain than a 50% reduction of absolute numbers and does not ‘punish’ countries for strong population growth.

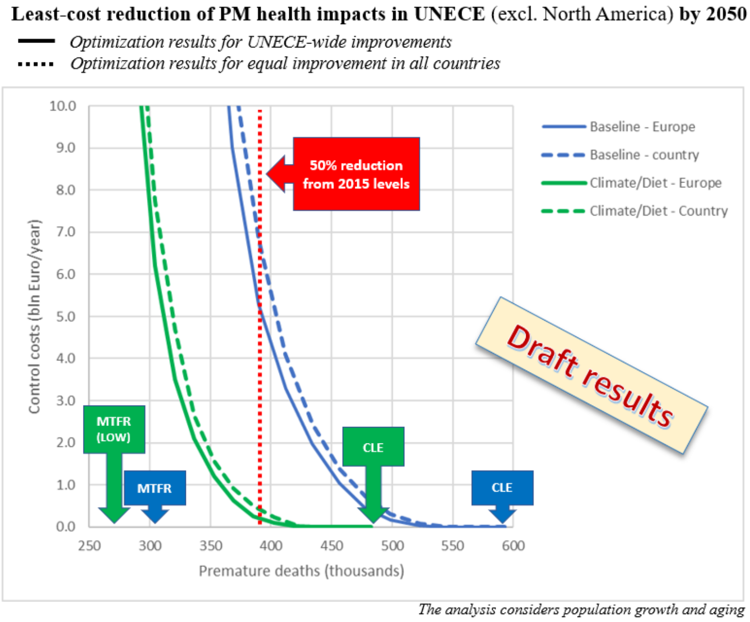
Figure 6: Mortality risk due to anthropogenic $PM_{2.5}$ (annual premature deaths per 100.000) in the UNECE-region (incl. North America)



17. For some countries, a 50% reduction of absolute premature death numbers between 2015 and 2050 would not be feasible, even with the LOW scenario. The GAINS model has been made ready to compute alternative, justifiable approaches, such as the least cost outcome to meet the health target for the UNECE as a whole (excluding North America), or an approach that requires an equal reduction percentage of the gap between baseline and MTFR by each party. The following paragraphs describe possible outcomes of such approaches. ***Note*** that they are preliminary and only meant as illustrations of the available modelling tool and target setting options. Absolute premature deaths are used here as a health indicator for the purpose of demonstrating the concept, this can be changed to other metrics, such as life years lost, or supplemented with morbidity indicators in subsequent analyses.

18. Full enforcement of baseline policies will achieve approximately 20% reduction of absolute premature deaths by 2050 compared to 2015 when considering population growth and aging. A UNECE-wide 70% gap closure of the range between baseline and MTFR would be sufficient to meet the 50% health risk reduction target (solid lines in Figure 7). An equal 70% gap closure per country would be more equitable. However, this will result in 30% higher costs (dashed lines in Figure 7). Inclusion of additional climate and dietary change policies (as in the LOW scenario) would already achieve over half of the emission reduction needed in 2040 or 2050 to reach a 50% reduction target from 2015 in absolute numbers of premature deaths (note that in figure 7, the ‘CLE’ starting point for the LOW scenario refers to the case where only current legislation, climate and dietary changes are implemented but not the additional MTFR measures as described in the LOW scenario definition in 3c; the latter case is indicated by the MTFR point on this line). Additional air pollution control costs would then be over ten times lower (see figure 7). Nevertheless, some countries are not achieving the 50% target or even show an increase in premature mortality compared to 2015 (see annex 1).

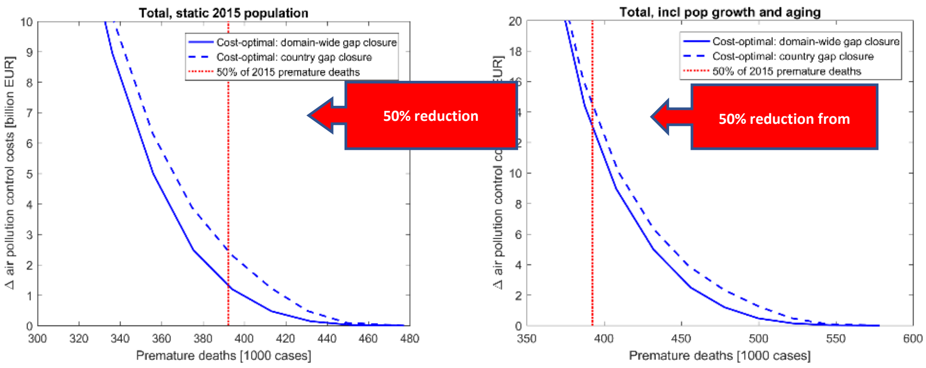
Figure 7: Cost curves (least cost options) for reducing the number of premature deaths in ***2050****. The target of 50% reduction between 2015 and 2050 is indicated as red dotted line. Two different starting points are used (blue – Baseline, indicated as CLE), green – Alternative LOW baseline with increased climate policies and dietary changes, Indicated as MTFR (LOW)) and two different ways of target setting are explored (solid line = UNECE-Europe region wide gap closure, dashed line = gap closure in each country). The distance on the x-axis between boxes of identical color indicates the full range of improvements that can be achieved with known measures.*



Source: GAINS model (CIAM)

19. Inclusion of population growth and aging would make it around ten times more expensive to meet the 50% reduction in premature mortality. For illustration in Figure 8 the 50% health target is applied for the period 2015-2040.

Figure 8: Least cost reduction of premature deaths due to anthropogenic $PM_{2.5}$ *in the UNECE (excl. North America) by* ***2040*** *for static population (left) and for dynamic population including growth and aging (right). Country gap closure percentages would be 40% in the static population case and 80% in the case with dynamic population.*

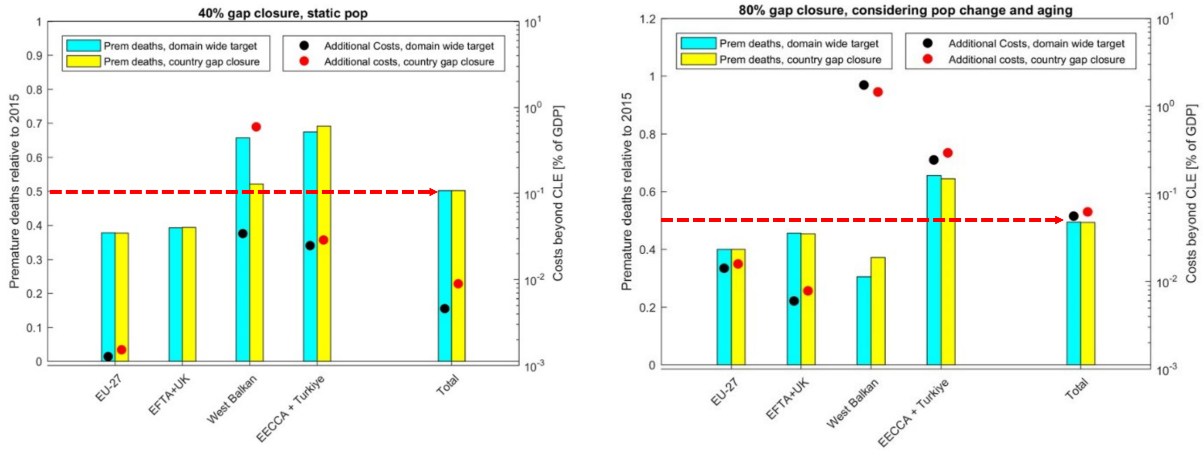


Source: GAINS model (CIAM)

20. Figure 9 shows illustrative least-cost results for 2040 of the gap closure approach for the UNECE as a whole and of a gap closure per country starting from the baseline projection for 2040. Premature deaths relative to 2015 are shown as bars (left axis) and costs beyond baseline relative to GDP as dots (right axis; note the logarithmic scale). A domain-wide target without any country target (cyan bars, black dots) has a different

distribution of impacts and costs, and lower total domain-wide costs, than a case where each country by itself would be required to achieve the same gap closure between baseline and MTFR. As a 50% health target will, in the EU, already be met with current legislation, these scenarios would mainly lead to additional costs in non-EU countries and in some countries exceed an equivalent of 0.5% of GDP. Relative differences in mortality between the two variants within each country are typically lower than differences in costs to achieve the target. In the case without population growth and aging (left graph), a gap closure of 40% between the 2040 baseline and MTFR is sufficient to reach the 50% reduction in premature deaths for the whole region. In this case, the additional costs for non-EU countries will generally be lower than 0.05% of GDP in most countries. In the case with demographic change (right graph), a gap closure of 80% between the 2040 baseline and MTFR would be needed to reach the 50% reduction in premature deaths for the whole region, and additional costs would be higher too, for some exceeding an equivalent of 0.5% GDP.

Figure 9: Country-group outcomes of least cost scenarios for 2040 to reduce the number of premature deaths by 50% between 2015 and 2040, with static population (left) and with population growth and aging (right), exploring two different variants of target setting: (cyan bars/black dots: domain wide gap closure without country targets; yellow bars/red dots: equal gap closure in each country)



Source: GAINS model (CIAM)

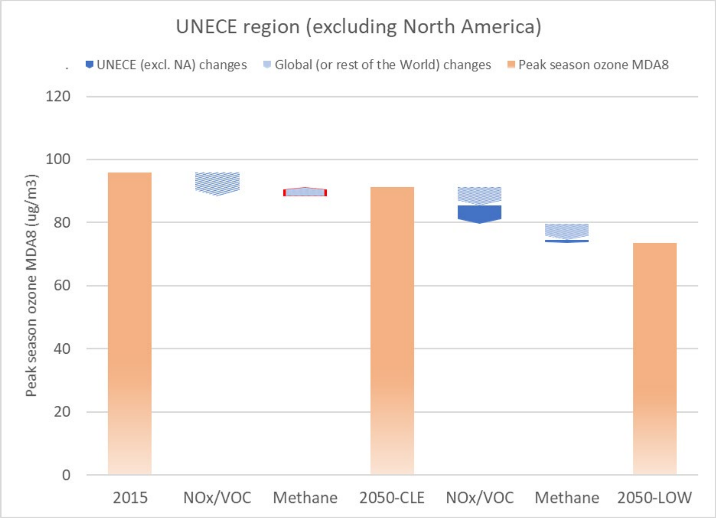
V. Options for ozone policy targets

21. In the baseline scenario, average ozone concentrations in Europe will increase by 2-5% between 2015 and 2050. Peak season concentrations will be reduced by around 5-10%. In both cases, the methane emission increase in the baseline scenario hampers the reductions expected from NO_x/VOC reductions within Europe.

22. CIAM estimates that with dietary change bringing reductions in livestock numbers, as included in the 2050 LOW scenario, methane emissions in the UNECE region can be reduced by almost 70% between 2015 and 2050. Combined with a 50% methane emission reduction in the rest of the World compared to 2015, the 2050 LOW scenario would reduce annual mean ozone concentrations by around 15% and peak season concentrations by around 25%. About 20% of the annual mean ozone reduction is driven by reductions in methane, compared to only 12% for peak season concentrations reductions. For mean ozone concentrations, transcontinental non-methane sources dominate over European sources, whilst for peak season concentrations, European NO_x and VOC sources dominate.

23. The difference in ozone concentrations (both ozone mean and ozone peak season) between the 2050 baseline and the 2050 LOW scenario can be attributed for roughly ⅓ to the reduction in global methane emissions, for ⅓ to the reduction of European non-methane precursor emissions and for ⅓ to the reduction of non-methane precursor emissions outside Europe (see figure 10).

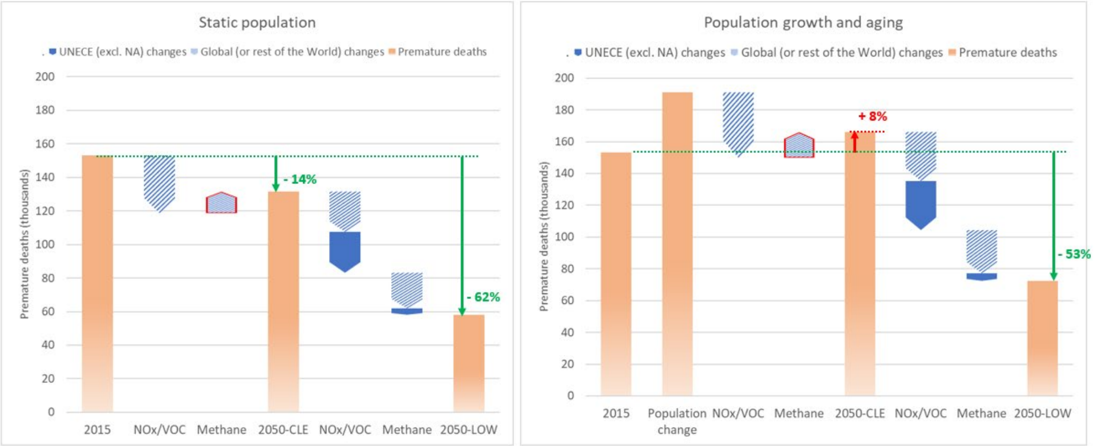
Figure 10: Reductions in the maximum 8-hours daily average concentrations (MDA8) in the ozone season



Source: EMEP model (MSC-W)

24. For ozone, too, the health impacts depend on whether population dynamics are included or not. When population growth and aging are considered, the absolute number of premature deaths in the whole UNECE region (excluding North America) would in the 2050 LOW scenario be 53% lower than in 2015. However, with the mortality risk-based approach, and the assumption of a static population, a decrease of 62% would be possible in the LOW scenario. Note that the number of premature deaths due to ozone is about 10 times lower than that of PM$_{2.5}$. These estimates, based on the peak-season ozone exposure, are preliminary.

Figure 11: Reduction in annual premature deaths due to ozone exposure in the UNECE-region (excl. North America) with expected population growth (right) and without population growth (left)



Source: EMEP (MSC-W) and GAINS (CIAM) models; split of impacts from UNECE vs global NO$_x$/VOC reductions preliminary and not yet available for 2015 to 2050 CLE case. Preliminary results pending further updates to health impact calculation methodology (HRAPIE2 upcoming).

VI. Options for the reduction of biodiversity risks

25. On the basis of data on the empirical critical loads for nitrogen, the risk of biodiversity loss due to air pollution can be assessed for various ecosystems.[5] Areas with an exceedance of the nitrogen critical load

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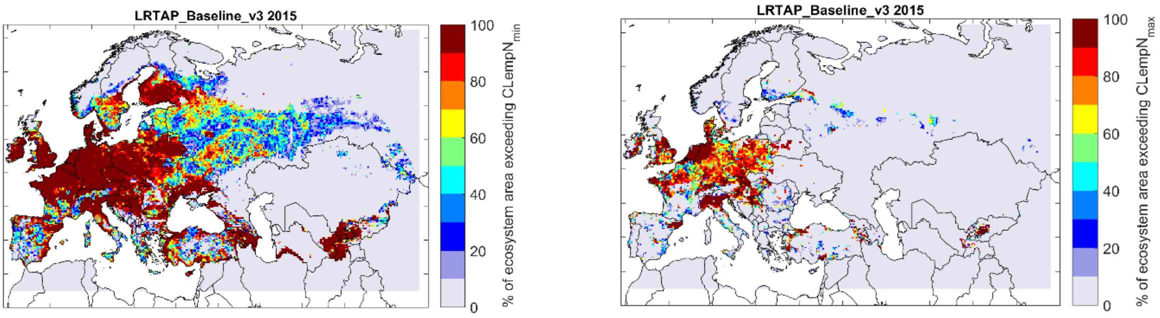
[5] Nitrogen deposition is one of the determinants of biodiversity loss. Also, climate change, drought, land use changes, pesticides, invasive species, ozone, etc. play a role. We apply the 50% target only to the air pollution related risks. That is

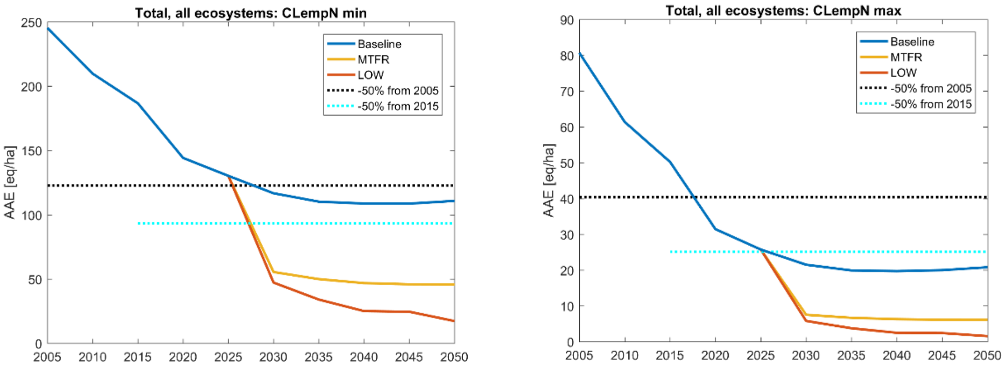
can be found throughout the UNECE-region. Figure 12 shows the share of the ecosystem area in a grid cell with an exceedance of the empirical nitrogen critical loads in 2015. The left graph refers to the minimum value for the critical load, the right to the maximum value. Marine ecosystems are not included in the analysis.

Figure 12: Percentage of ecosystem area exceeding the empirical nitrogen critical load in 2015 (lower critical load values left, higher values right)



26. The Working Group on Effects sees the average amount of exceedance of critical loads in an area as a better indicator for the risk of biodiversity loss than the percentage of the area with a (sometimes very low) exceedance. Figure 13 shows the development of Average Accumulated Exceedance (AAE) between 2005 and 2050 for all ecosystems using the lower levels of nitrogen critical loads ($CL_{empNmin}$, left) and upper levels ($CL_{empNmax}$, right). The dotted lines show the 50% reduction target compared to 2005 (black) and 2015 (cyan) respectively. The lower and upper critical loads limits show a big difference in policy implication. The upper limit will not require additional policy ambitions. Further analysis could be based on the mean value, and a sensitivity analysis could be valuable using the lower value of critical loads.

Figure 13: Attainability of 50% reduction of the Average Accumulated Exceedance of the nitrogen critical loads for all ecosystems in the UNECE region, excluding North America. (Lower critical load levels left, upper limits right)



27. The attainability of the 50% reduction target differs among countries and among ecosystem types (see figures 14 and 15). A 50% reduction of the Average Accumulated Exceedance can be met in most countries even when using the lower critical loads levels. The exceptions are EECCA and Türkiye where a large increase in fertilizer use is included in the baseline (figure 14).

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comparable with the approach of health risks, that are only applied to PM-related impacts, although there a more factors influencing health, such as smoking, drinking, unhealthy diets, and lack of exercise.

Figure 14: Attainability of 50% reduction of the Average Accumulated Exceedance of the minimum nitrogen critical loads for all ecosystems within UNECE regions

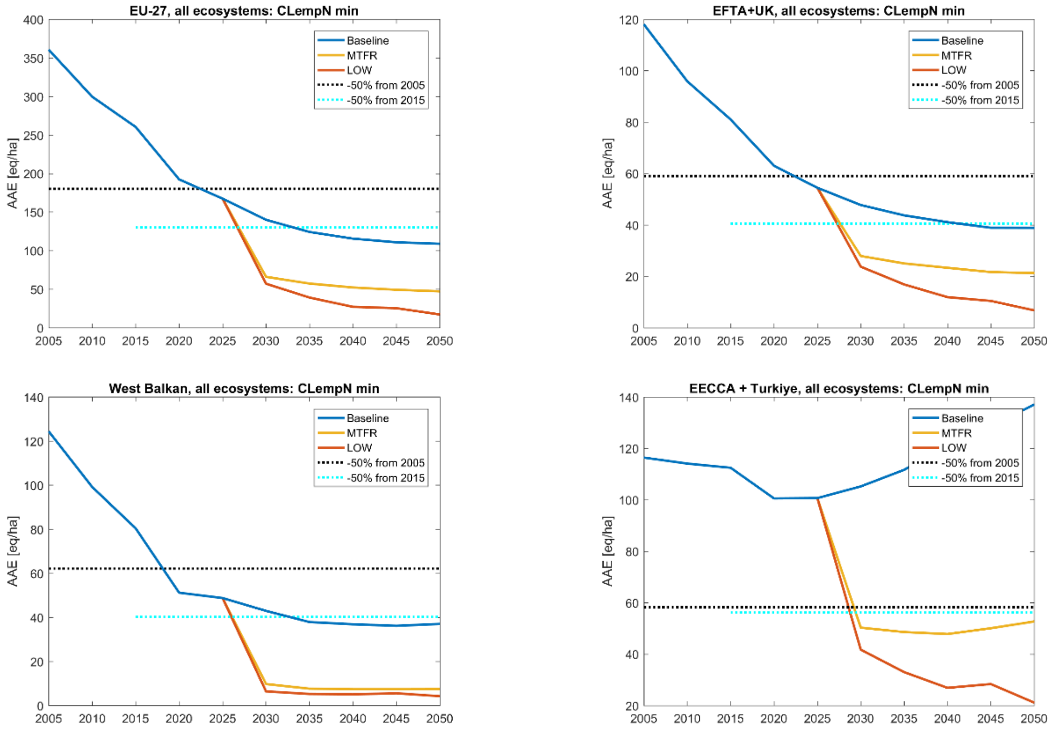
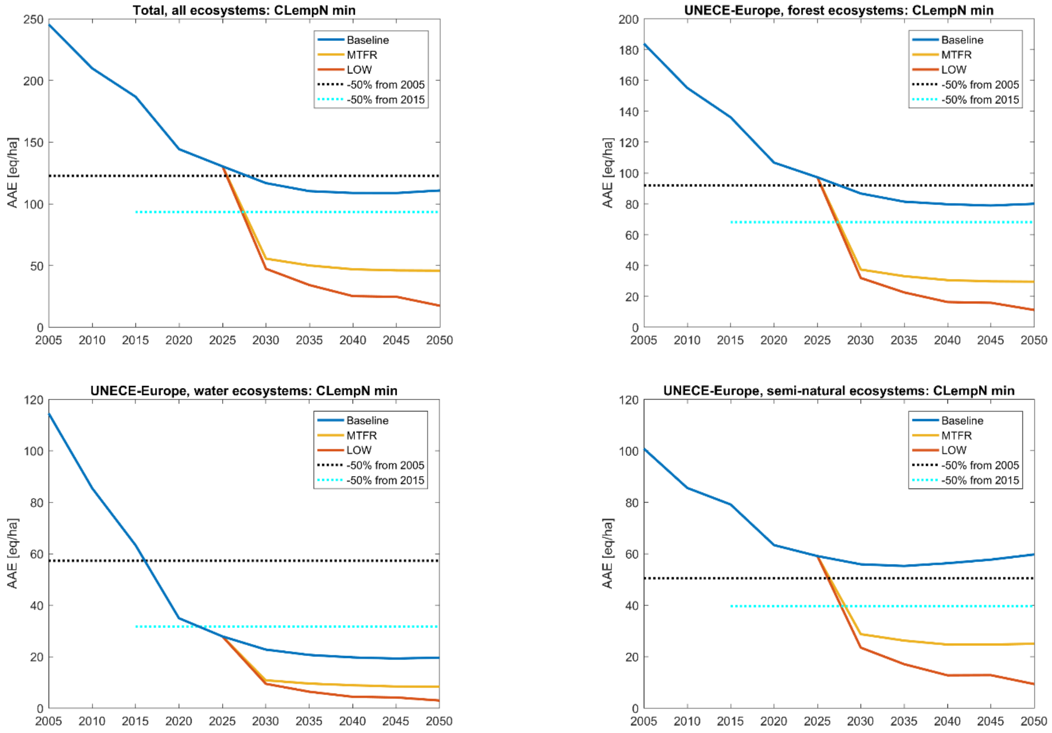


Figure 15: Attainability of 50% reduction of the Average Accumulated Exceedance of the minimum nitrogen critical loads for specific ecosystems



28. Additional efforts seem to be needed to reach a 50% risk reduction relative to 2015 for forests and semi-natural ecosystems (such as heathlands, mountain meadows and dunes), especially when 2015 is used as base year (figure 15). Additional ammonia emissions reduction would play a key role here. MTFR measures for ammonia emissions as well as the dietary measures in the LOW scenario could offer sufficient scope for meeting the 50% target. Of course the attainablity will be different at the national level. This requires further analyses and exploration of optimization scenarios. This is foreseen for September 2024. Also, if data can be provided by the Working Group on Effects, comparisons can be made with the use of the calculated critical loads for nitrogen and acidification based on a mass-balance approach.

VII. Options for the inclusion of sectoral and staged/phased approaches

29. Additional hybrid scenarios are under discussion and development aiming at flexibilities that could encourage ratification by EECCA and West Balkan countries. For this, so called ‘staged’ or gradual ‘phase-in’ approaches are under discussion, which could include prioritization of measures addressing, for example, particular sectors where not only significant impact benefits can be achieved, but that have already high policy priority owing to other ongoing European processes or the existence of experiences in how significant reductions can be achieved.

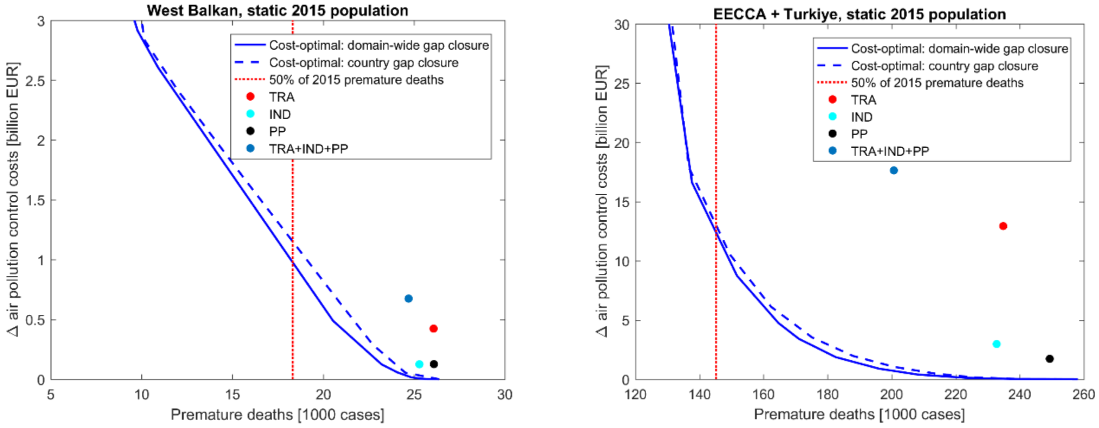
30. Discussions are ongoing on the development of such scenarios that exclude West Balkan, EECCA and Türkiye from the GAINS model optimization and allow them to comply with emission limit values for specific sources at a certain point in time. The optimized scenarios will then apply to EU and EFTA+UK. Sectors that have been proposed for a staged/phased adoption of the EU emission limit values are:

PP: Power- and heating plants;
IND: Industrial combustion and processes;
TRA: Road and off-road machinery.

All other sectors will remain as in the baseline.

31. Indicative results show that such a hybrid scenario would give less health risk reduction between 2015 and 2040 for the countries involved and would be less cost-effective. Figure 16 shows – for the regions involved - the costs and health impacts for the application of emission limit values for the three sectors separately (red, cyan and black dots) and for all three sectors together (blue dots), compared with their costs and impacts according to a domain wide optimized approach (solid lines) and country-specific optimisation approach (dashed lines). While a sizable health improvement is estimated in the staged approach (especially for EECCA), the costs are much larger relative to the achieved benefits in this preliminary staged approach case. This is so because some of the mitigation potential mobilized in the staged approach case is beyond the cost-effective portfolio of solutions to reach domain wide or country specific goals.

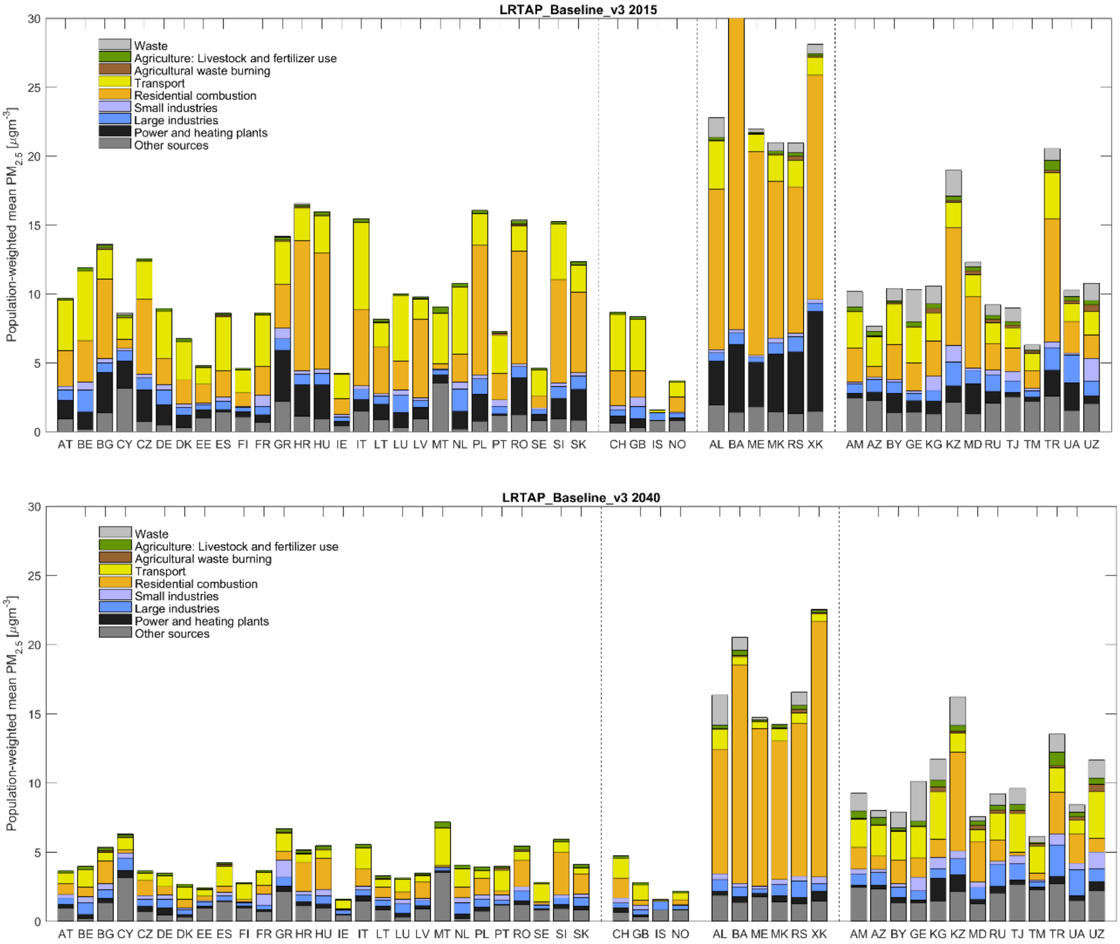
Figure 16: Premature deaths and abatement costs in 2040 for West-Balkan (left) and EECCA+Türkiye (right) according to domain wide optimization (blue lines) and with application of EU-emission limit values for selected sectors (dots).



Source: GAINS model (CIAM)

32. For industrial installations (cyan dots) and the power plants (black dots), the results of the staged approach and the domain wide optimized scenario are comparable. For transport (red dots) the staged approach would mobilize additional mitigation compared to the optimized approach, especially for the EECCA where current polices assume low ambition. Since the staged approach explores full potential of abatement measures, including those that are beyond what is found cost-effective in the optimized solutions, the costs for transport are much higher in the staged approach vs the optimized case. The optimized scenarios also address other sectors, especially residential combustion. Significant health benefits cannot be reached without addressing residential combustion (see figure 17). At the request of WGSR 62, refined and additional staged scenarios could be made available for discussion during the informal WGSR meeting in October 2024.

Figure 17: Sector contributions to population weighted country mean anthropogenic $PM_{2.5}$ concentrations in 2015 (top) and according to the baseline in 2040 (bottom) – draft results



Source: GAINS model (CIAM)

VIII. Conclusions

33. The target setting options presented in this policy brief offer many possibilities. The large number of tables and graphs might obscure a clear vision of what must be negotiated for a revised protocol. For an efficient negotiation process, it is recommended to consider narrowing the number of choices. This could include focusing for the moment on health and biodiversity risk reduction targets for the period 2015 to 2040. For 2015, emission data for many EECCA and West Balkan countries are more reliable than 2005 data. And for policy making 2050 might be too far away, while 2030 is too close.

34. A 50% health target between 2015 and 2040 (in terms of premature deaths due to anthropogenic PM) appears achievable in the UNECE region as a whole, for most regions (groups of countries), and for many single countries, but not all. Feasibility depends on details of the calculation, reference year, formulation of other potential targets (e.g., for cities, adding morbidity, etc.). For the EU, the target is achieved in the baseline scenario. For this region, full implementation and enforcement remains a key priority and an important assumption. Some non-EU countries may struggle to achieve such a target especially when population growth and aging are taken into account. A risk-based target with static population or mortality risks per 100.000 inhabitants seem more achievable. A 50% target for the whole region would be more cost-effective, however less equitable, than the same target for all countries. This preliminary analysis shows that pursuing additional climate measures and dietary change policies (such as in the LOW-scenario) could reduce additional air pollution control costs ten-fold.

35. A 50% target for the reduction of premature deaths between 2015 and 2040 will be more challenging than 50% reduction between 2005 and 2050, but such a target is still attainable for many countries directly, or with an equal gap-closure approach (equal reduction of the gap between baseline and MTFR). A 40% reduction of the feasible range (‘gap closure’) allows achieving the 50% health target in the static population case; 80% gap closure would be needed for the dynamic population case.

36. Total costs and the distribution of costs vary significantly between the cases (equivalent to less than 0.1% GDP to over 1% GDP at the regional level) with higher costs for the case where equal improvements in all countries are achieved. Further analysis would be required to assess the impact of a constraint for each country setting the maximum costs per GDP (this is tentatively scheduled for the second part of 2024).

37. A 50% target for the reduction of premature deaths due to ground level ozone between 2015 and 2050 is challenging. Current air pollution policies are largely offset by the global increase in methane emissions. Contrary to $PM_{2.5}$, the feasibility of the ozone target is more dependent on global cooperation to reduce ozone precursors, including methane, In the 2050 LOW scenario, reductions of NO_x and NMVOC-emissions within the UNECE (excl. North America) would contribute 1/3 to the reduction of its ozone levels, while global methane reduction and global reduction of NO_x and NMVOC would also contribute 1/3 respectively (see figure 10). Global action on methane would be a key part of the solution and further NO_x and NMVOC emission mitigation would still be important to reduce ground level ozone within the UNECE region.

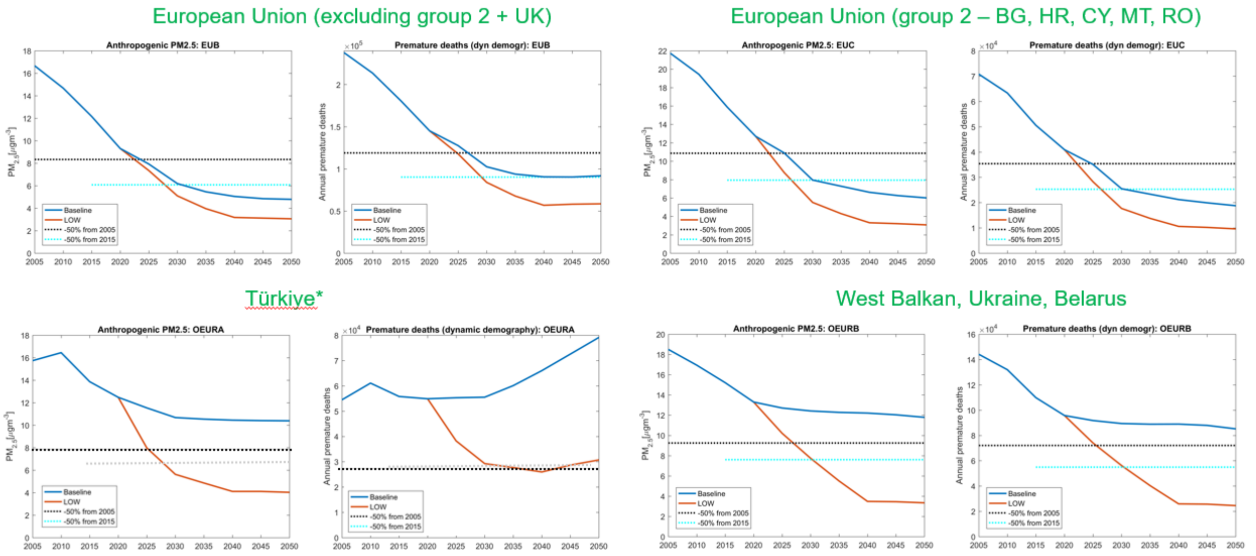
38. The 2050 LOW scenario would, in EU and non-EU countries compared to 2015, lead to more than 50% reduction in the area with an exceedance of critical loads, for acidification as well as for eutrophication. A domain wide 50% reduction of the area average exceedance between 2015 and 2040 is attainable but would require additional (ammonia) reduction measures when applied for forests or semi-natural vegetation. Optimization scenarios for biodiversity targets are planned (first results are envisaged for September 2024).

39. Next steps in the GAINS modelling include implementing optimization for combined biodiversity and PM and ozone impacts (which could be made available in 2025). Further analysis could consider, inter alia, alternative metrics for target setting, including achievement of other health end-point indicators, marine ecosystem targets or targets for the climate impact of black carbon particles, or for urban hot-spots. Further work is needed to include the latest climate measures (i.e. the use of hydrogen and ammonia as well as peat land restoration), fine-tuning the various options for staged-phased approaches, and on sensitivity of outcomes for uncertain input data, such as uncertainties in emission estimates (e.g. of condensables), uncertainties in full implementation of climate policies and uncertainties in cost estimates.

40. If agreed by the WGSR, where relevant, such elements will also have to be included in the workplan of other scientific bodies under the Convention than TFIAM and CIAM.

Annex 1: Attainability of health improvement goals in selected regions

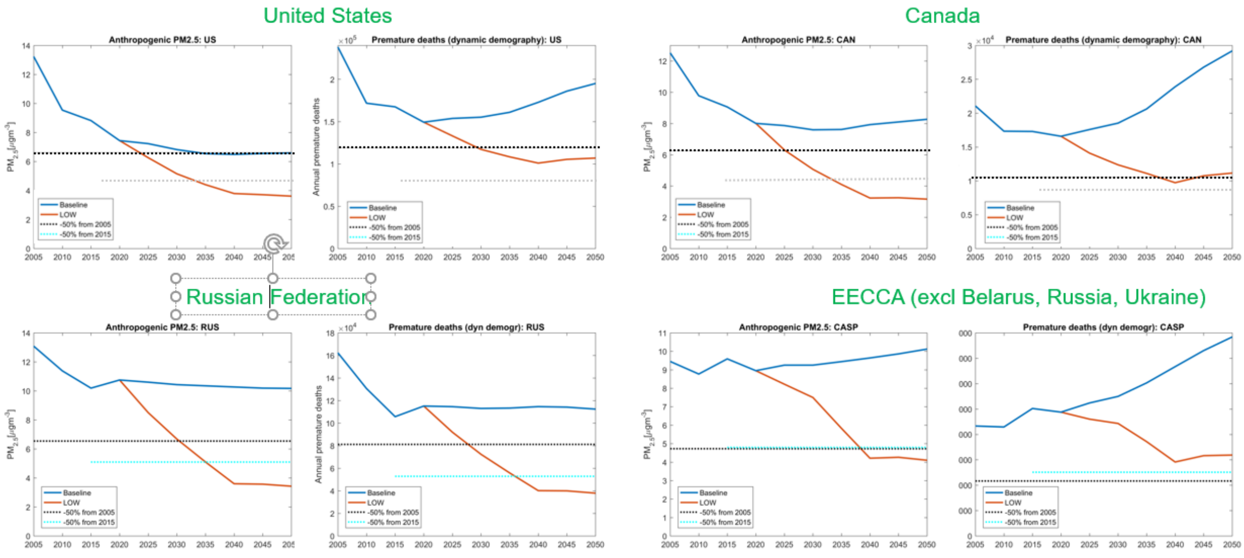
Figure A.1: Change in PM$_{2.5}$ concentrations and number of premature deaths (taking into account population change and aging – dynamic demography) for Baseline and LOW scenarios (1)[6]



*also IS, NO, CH, IL

Source: GAINS model (CIAM/IIASA)

Figure A.2: Change in PM$_{2.5}$ concentrations and number of premature deaths (taking into account population change and aging – dynamic demography) for Baseline and LOW scenarios (2)



Source: GAINS model (CIAM/IIASA)

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[6] Country groups are only illustrative at the moment and will be adjusted later.

Annex 2: Country tables

Table 1 shows emissions in for the scenarios analyzed so far, aggregated to country groups, for 2005, 2030 and 2050. Tables 2-6 show health and ecosystem impact indicators across all countries for 2015 and for 2030 and 2050 for the scenarios analyzed so far and compare these to the impact levels that would have been achieved if the GP commitments were met for all pollutants and countries consistently through 2030 (indicated with “GP compliant” in the tables).

Table 1: Emissions in GAINS-LRTAP scenarios

SO2 - kt SO2		Baseline		MTFR		LOW	
Region	2005	2030	2050	2030	2050	2030	2050
EU-27	6798	794	578	621	322	621	322
EFTA+UK	818	169	131	149	112	104	72
West Balkan	886	181	123	141	44	107	15
EECCA+Turkiye	6530	3629	3938	2714	887	1980	545
North America	15765	2865	2640	2159	1177	1550	959
Total	**30796**	**7639**	**7411**	**5783**	**2542**	**4362**	**1914**

NOx - kt NO2 (soil NOx is excluded)

Region	2005	2030	2050	2030	2050	2030	2050
EU-27	9694	2463	1331	2161	882	2161	882
EFTA+UK	1960	545	325	484	238	484	205
West Balkan	269	162	130	128	73	114	44
EECCA+Turkiye	6277	4736	5290	3510	1498	3122	950
North America	19025	7637	6589	5853	3455	5180	1843
Total	**37225**	**15543**	**13666**	**12137**	**6146**	**11062**	**3923**

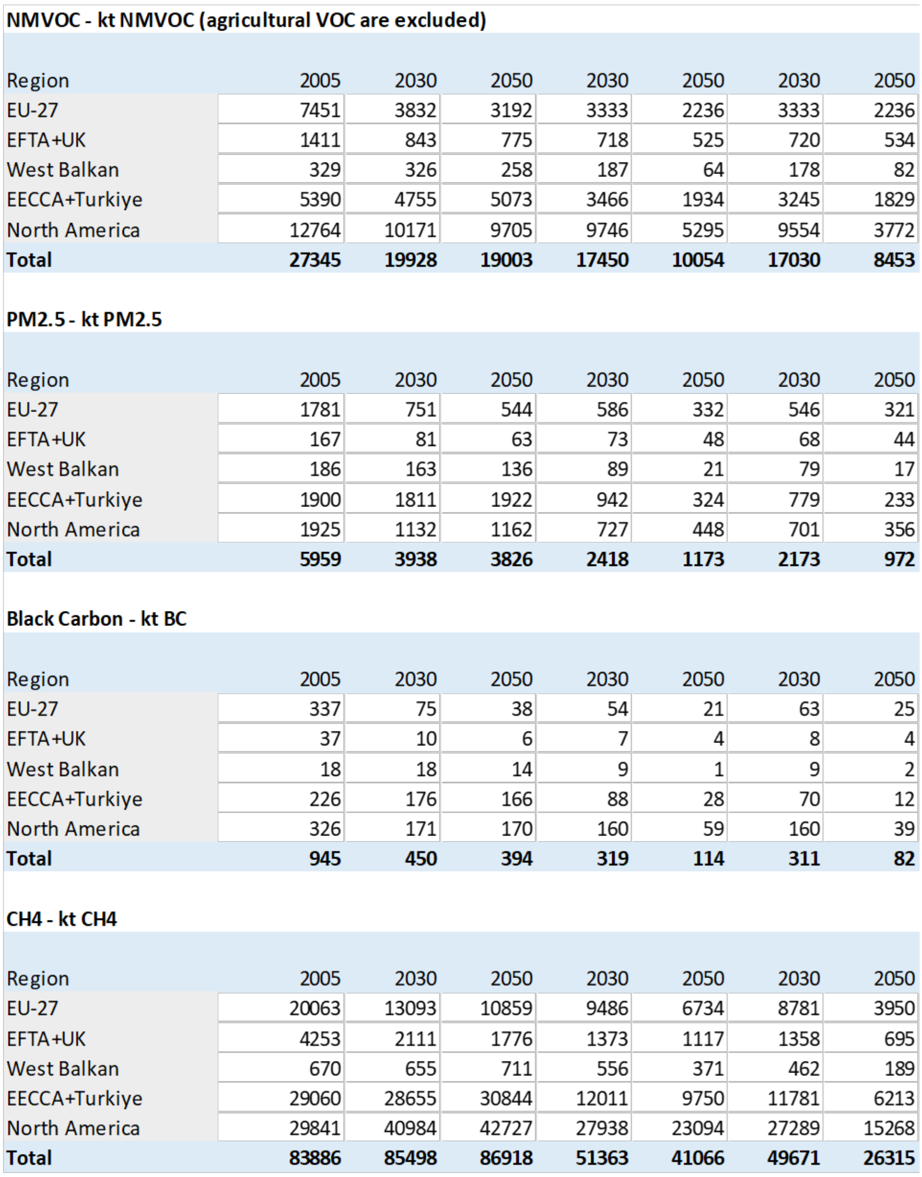
NOx - kt NO2 (soil NOx included)

Region	2005	2030	2050	2030	2050	2030	2050
EU-27	10470	3236	2061	2680	1372	2631	1196
EFTA+UK	2072	646	426	554	308	556	254
West Balkan	291	186	157	145	92	128	56
EECCA+Turkiye	6720	5295	5906	3902	1928	3459	1201
North America	19627	8342	7313	6161	3768	5463	2049
Total	**39180**	**17705**	**15864**	**13441**	**7467**	**12237**	**4756**
Increase due soil	105%	114%	116%	111%	122%	111%	121%

NH3 - kt NH3

Region	2005	2030	2050	2030	2050	2030	2050
EU-27	3813	3403	3267	2939	2327	2756	1460
EFTA+UK	391	352	358	309	267	289	177
West Balkan	106	112	117	96	83	81	54
EECCA+Turkiye	1926	2250	2577	1959	1937	1885	1278
North America	4274	4915	5190	3906	3037	3492	1667
Total	**10510**	**11031**	**11508**	**9209**	**7651**	**8503**	**4635**

Table 1, continued: Emissions in GAINS-LRTAP scenarios



NMVOC - kt NMVOC (agricultural VOC are excluded)

Region	2005	2030	2050	2030	2050	2030	2050
EU-27	7451	3832	3192	3333	2236	3333	2236
EFTA+UK	1411	843	775	718	525	720	534
West Balkan	329	326	258	187	64	178	82
EECCA+Turkiye	5390	4755	5073	3466	1934	3245	1829
North America	12764	10171	9705	9746	5295	9554	3772
Total	**27345**	**19928**	**19003**	**17450**	**10054**	**17030**	**8453**

PM2.5 - kt PM2.5

Region	2005	2030	2050	2030	2050	2030	2050
EU-27	1781	751	544	586	332	546	321
EFTA+UK	167	81	63	73	48	68	44
West Balkan	186	163	136	89	21	79	17
EECCA+Turkiye	1900	1811	1922	942	324	779	233
North America	1925	1132	1162	727	448	701	356
Total	**5959**	**3938**	**3826**	**2418**	**1173**	**2173**	**972**

Black Carbon - kt BC

Region	2005	2030	2050	2030	2050	2030	2050
EU-27	337	75	38	54	21	63	25
EFTA+UK	37	10	6	7	4	8	4
West Balkan	18	18	14	9	1	9	2
EECCA+Turkiye	226	176	166	88	28	70	12
North America	326	171	170	160	59	160	39
Total	**945**	**450**	**394**	**319**	**114**	**311**	**82**

CH4 - kt CH4

Region	2005	2030	2050	2030	2050	2030	2050
EU-27	20063	13093	10859	9486	6734	8781	3950
EFTA+UK	4253	2111	1776	1373	1117	1358	695
West Balkan	670	655	711	556	371	462	189
EECCA+Turkiye	29060	28655	30844	12011	9750	11781	6213
North America	29841	40984	42727	27938	23094	27289	15268
Total	**83886**	**85498**	**86918**	**51363**	**41066**	**49671**	**26315**

Table 2: Population exposed to $PM_{2.5}$ levels above 5 µg/m^3 (million), preliminary results

		Baseline		MTFR		LOW		GP compliant	
Country	2015	2030	2050	2030	2050	2030	2050	2030	2050
Austria	8,3	7,0	4,0	3,4	0,5	3,3	0,3	6,2	
Belgium	11,3	11,9	10,4	10,9	3,7	10,5	1,1	11,8	
Bulgaria	7,2	6,1	4,9	4,9	0,1	4,0	0,3	6,1	
Croatia	4,2	3,7	2,8	3,5	0,3	3,2	0,0	3,7	
Cyprus	1,2	1,3	1,4	1,3	1,4	1,3	1,4	1,3	
Czech Rep.	10,6	10,2	4,1	3,5	-	2,8	-	9,9	
Denmark	5,7	4,9	0,0	4,5	-	1,7	-	4,6	
Estonia	0,7	0,0	0,0	-	-	-	-	-	
Finland	2,4	1,1	0,8	0,6	-	0,6	0,6	0,9	
France	63,3	45,5	25,5	31,2	16,4	25,1	12,4	40,4	
Germany	81,7	78,3	35,6	36,9	3,6	33,2	2,8	74,3	
Greece	11,2	10,7	9,6	10,4	8,4	9,9	7,1	10,7	
Hungary	9,8	9,2	7,5	8,7	-	8,2	0,9	9,2	
Ireland	4,0	-	-	-	-	-	-	-	
Italy	59,2	56,3	50,4	55,6	47,7	54,7	31,7	55,9	
Latvia	1,9	0,7	0,2	0,2	-	0,2	-	0,5	
Lithuania	2,9	1,4	0,2	0,0	-	0,0	-	1,3	
Luxembourg	0,6	0,7	0,1	-	-	-	-	0,7	
Malta	0,4	0,4	0,4	0,4	0,4	0,4	0,4	0,4	
Netherlands	16,9	17,6	17,5	17,6	9,7	17,6	0,8	17,6	
Poland	38,3	35,6	13,0	10,9	0,0	10,0	-	35,4	
Portugal	10,0	7,0	5,0	5,5	4,3	3,5	1,1	6,9	
Romania	19,9	17,0	13,1	11,5	1,8	10,0	2,0	16,7	
Slovakia	5,4	5,0	2,1	2,0	-	1,7	-	4,9	
Slovenia	2,1	2,0	1,3	1,7	0,1	1,6	0,2	2,0	
Spain	43,1	34,5	28,7	32,3	26,4	29,9	15,4	33,8	
Sweden	5,1	2,7	1,6	1,8	0,4	0,8	0,9	2,4	
EU-27	**427,3**	**370,6**	**240,4**	**259,3**	**125,4**	**234,2**	**79,2**	**357,5**	
Albania	2,9	2,9	2,6	2,9	2,3	2,9	1,7	2,9	
Armenia	2,9	2,9	2,7	2,9	2,7	2,9	2,7	2,9	
Azerbaijan	9,5	10,6	11,0	10,5	10,9	10,5	11,0	10,6	
Belarus	9,5	8,9	7,8	5,1	-	4,6	0,6	8,8	
Bosnia-H	3,5	3,4	2,9	3,3	1,2	3,1	0,8	3,4	
Georgia	3,7	3,5	3,2	3,4	2,3	3,4	2,3	3,5	
Iceland	0,1	0,1	0,1	0,1	0,1	-	-	0,1	
Kazakhstan	17,5	19,6	22,6	19,5	21,4	18,8	19,6	19,6	
Kosovo	1,8	1,6	1,2	1,0	0,1	0,9	0,2	1,6	
Kyrgyzstan	5,5	6,6	7,9	6,8	7,7	6,7	7,0	6,6	
North Macedonia	2,1	2,0	1,8	1,9	0,7	1,7	0,6	2,0	
R Moldova	4,1	3,8	3,3	3,8	-	2,3	-	3,8	
Montenegro	0,6	0,5	0,4	0,0	0,0	0,0	0,0	0,5	
Norway	1,3	0,3	0,3	0,3	-	-	0,7	0,5	
Russia	97,7	92,7	84,1	77,6	38,7	69,5	36,4	92,7	
Serbia	8,9	8,4	7,2	6,0	0,0	5,5	0,8	8,4	
Switzerland	7,9	7,7	7,9	6,0	1,4	6,2	3,9	7,6	
Tajikistan	-	-	-	-	-	-	-	-	
Türkiye	78,1	87,7	94,8	86,4	84,8	85,0	79,8	87,7	
Turkmenistan	-	-	-	-	-	-	-	-	
Ukraine	44,7	40,7	35,9	35,4	11,3	32,7	13,1	40,7	
United Kingdom	64,3	55,5	14,1	51,4	9,2	38,7	6,0	55,0	
Uzbekistan									
Non-EU	**366,6**	**359,5**	**311,9**	**324,6**	**194,8**	**295,4**	**187,3**	**358,9**	
Total	**793,9**	**730,1**	**552,3**	**583,9**	**320,2**	**529,6**	**266,5**	**716,4**	

Table 3: Years of life lost due to anthropogenic $PM_{2.5}$ exposure (million), cumulative over population lifetime, preliminary results

		Baseline		MTFR		LOW		GP compliant	
Country	2015	2030	2050	2030	2050	2030	2050	2030	2050
Austria	6,1	3,116	2,275	2,644	1,722		1,575	2,737	
Belgium	10,0	5,046	3,664	4,311	2,698		2,339	4,916	
Bulgaria	7,9	4,301	3,181	3,179	1,734		1,567	4,18	
Croatia	5,5	2,453	1,691	1,766	0,989		0,886	2,377	
Cyprus	0,6	0,468	0,452	0,386	0,298		0,284	0,46	
Czech Rep.	10,6	4,756	3,325	3,984	2,306		2,064	4,388	
Denmark	3,0	1,676	1,242	1,416	0,877		0,774	1,66	
Estonia	0,6	0,367	0,297	0,298	0,195		0,171	0,315	
Finland	1,8	1,181	1,055	1,07	0,864		0,825	1,148	
France	41,0	22,266	17,668	19,518	13,726		12,675	21,059	
Germany	56,6	30,446	23,209	26,131	17,233		15,383	28,705	
Greece	11,4	5,753	5,113	4,757	3,708		3,551	5,686	
Hungary	13,6	7,104	4,253	5,317	2,695		2,399	6,933	
Ireland	1,4	0,71	0,582	0,617	0,447		0,399	0,699	
Italy	63,0	31,188	22,830	28,482	17,362		16,024	29,602	
Latvia	1,8	0,949	0,635	0,729	0,397		0,366	0,903	
Lithuania	2,4	1,384	0,982	1,033	0,583		0,522	1,324	
Luxembourg	0,3	0,164	0,119	0,143	0,089		0,081	0,159	
Malta	0,2	0,191	0,199	0,162	0,141		0,137	0,189	
Netherlands	14,2	7,771	5,723	6,721	4,304		3,736	7,529	
Poland	50,2	19,233	13,217	15,877	8,51		7,957	19,147	
Portugal	5,0	3,006	2,707	2,495	1,873		1,859	2,979	
Romania	25,7	12,42	9,290	9,494	5,348		4,793	11,674	
Slovakia	5,9	2,65	1,836	2,09	1,163		1,036	2,571	
Slovenia	2,2	1,232	0,678	0,903	0,431		0,408	1,225	
Spain	26,6	14,696	12,535	14,296	8,839		8,59	14,288	
Sweden	3,0	2,012	1,726	1,818	1,432		1,359	1,972	
EU-27	**371**	**187**	**140**	**160**	**100**	**0**	**92**	**179**	
Albania	**5**	3,493	3,735	2,249	1,118		0,998	3,448	
Armenia	3	2,396	2,406	1,864	1,122		1,116	2,394	
Azerbaijan	6	5,826	6,641	5,183	3,315		2,79	5,823	
Belarus	9	7,519	7,066	5,474	2,668		2,292	7,300	
Bosnia-H	10	6,538	5,724	4,165	1,497		1,17	6,427	
Georgia	3	3,207	3,434	2,572	1,328		1,196	3,203	
Iceland									
Kazakhstan									
Kosovo	4	3,266	2,930	2,077	0,744		0,551	3,206	
Kyrgyzstan									
North Macedonia	3	2,232	2,065	1,473	0,697		0,558	2,198	
R Moldova	4	3,018	2,845	2,128	1,148		0,876	2,878	
Montenegro	1	0,792	0,686	0,514	0,195		0,155	0,778	
Norway	1	0,786	0,691	0,724	0,576		0,686	0,807	
Russia	90	91,9	89,376	64,848	35,76		30,04	91,664	
Serbia	15	13,893	9,672	9,011	3,186		2,509	13,682	
Switzerland	5	3,111	2,620	2,78	2,028		1,892	2,896	
Tajikistan									
Türkiye	107	80,857	63,154	62,187	32,429		28,423	80,346	
Turkmenistan									
Ukraine	43	35,293	37,629	24,838	14,043		11,562	35,025	
United Kingdom	40	20,374	14,758	17,546	11,18		10,044	19,915	
Uzbekistan									
Non-EU	**350**	**285**	**255**	**210**	**113**	**0**	**97**	**282**	**0**
Total	**721**	**471**	**396**	**369**	**213**	**0**	**189**	**461**	**0**

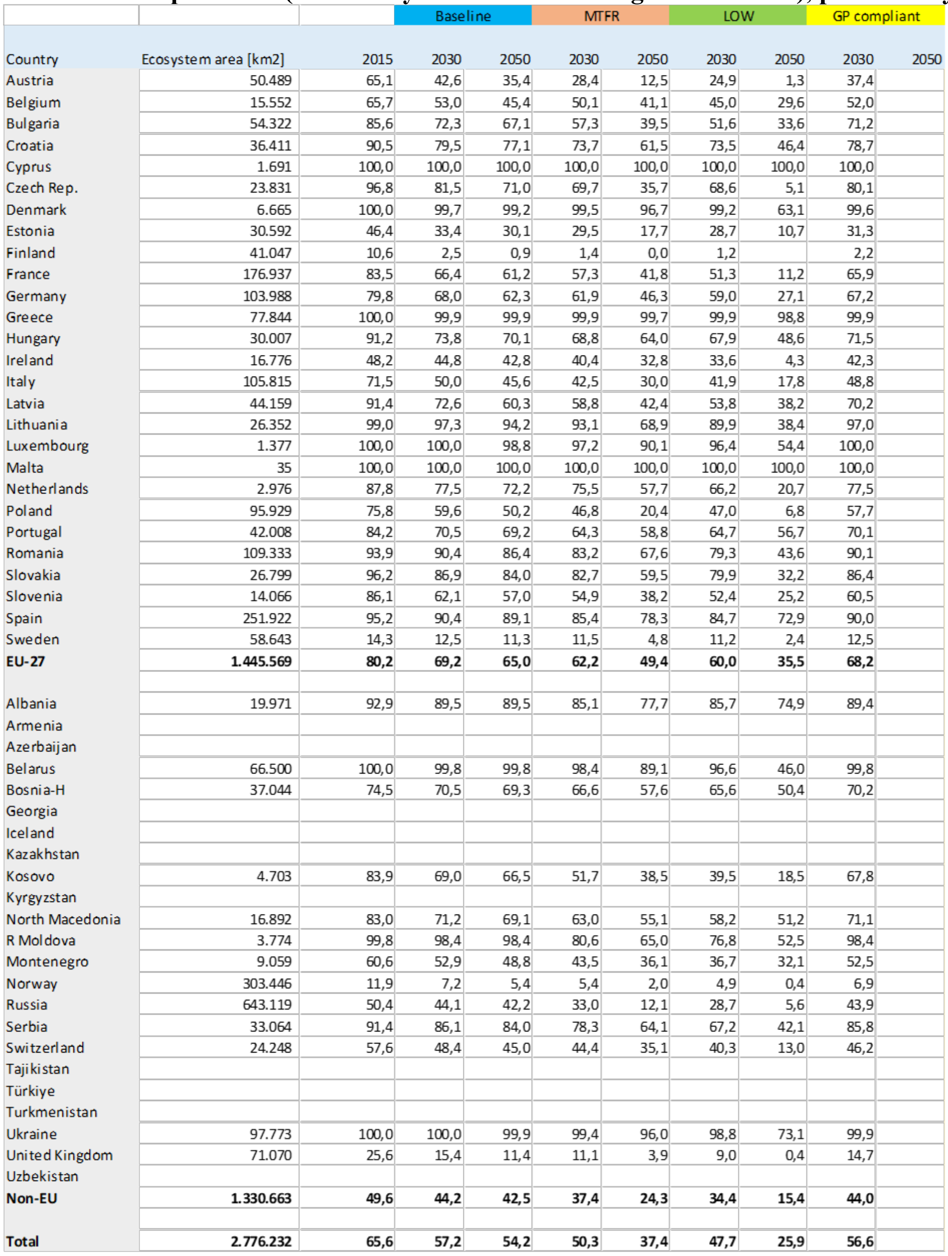
Table 4: Premature deaths from ozone (cases/yr), preliminary results

		Baseline		MTFR		LOW		GP compliant	
Country	2015	2030	2050	2030	2050	2030	2050	2030	2050
Austria	475	319	336	284	275	279	254	316	
Belgium	362	272	299	252	261	248	246	271	
Bulgaria	596	431	344	373	268	360	244	430	
Croatia	312	197	166	172	130	169	120	196	
Cyprus	54	60	86	55	74	55	71	60	
Czech Rep.	537	384	342	338	274	332	254	382	
Denmark	131	110	110	100	93	99	88	109	
Estonia	23	17	15	15	12	15	11	17	
Finland	70	62	65	57	54	56	51	62	
France	2206	1787	2004	1635	1752	1614	1654	1779	
Germany	3752	2786	2675	2532	2273	2496	2126	2769	
Greece	669	579	633	525	531	515	502	578	
Hungary	678	474	392	410	306	399	279	472	
Ireland	60	65	89	63	84	63	83	65	
Italy	4695	3522	3630	3251	3106	3239	3001	3506	
Latvia	53	36	28	31	21	31	19	36	
Lithuania	92	66	55	57	41	56	37	66	
Luxembourg	18	13	16	12	13	12	13	13	
Malta	22	23	27	21	25	21	24	23	
Netherlands	382	334	381	307	329	303	308	332	
Poland	1463	1075	1008	933	775	916	715	1071	
Portugal	435	378	421	358	388	357	382	376	
Romania	1247	945	834	812	630	786	575	943	
Slovakia	274	204	196	177	151	173	139	204	
Slovenia	112	79	80	70	64	69	60	79	
Spain	2113	1893	2273	1772	2061	1761	2012	1890	
Sweden	168	132	137	120	116	119	109	132	
EU-27	**21001**	**16244**	**16644**	**14734**	**14106**	**14542**	**13375**	**16176**	
Albania	126	129	155	112	120	110	112	128	
Armenia	203	206	246	193	199	191	190	206	
Azerbaijan	245	327	513	295	359	287	336	327	
Belarus	271	202	184	173	135	169	124	201	
Bosnia-H	217	160	152	139	116	134	107	160	
Georgia	206	169	176	157	123	154	115	169	
Iceland	4	5	7	5	7	5	7	5	
Kazakhstan	0	0	0	0	0	0	0		
Kosovo	51	39	34	34	27	33	24	39	
Kyrgyzstan	0	0	0	0	0	0	0		
North Macedonia	140	117	123	104	100	101	91	117	
R Moldova	208	177	188	153	137	147	125	177	
Montenegro	37	30	31	27	25	25	23	30	
Norway	81	74	93	70	85	70	83	74	
Russia	3099	2875	2867	2588	2249	2528	2133	2872	
Serbia	559	406	341	347	258	332	229	405	
Switzerland	387	315	372	289	317	286	296	306	
Tajikistan	0	0	0	0	0	0	0		
Türkiye	2444	2803	4049	2639	3611	2616	3521	2801	
Turkmenistan	0	0	0	0	0	0	0		
Ukraine	2580	1986	1797	1745	1373	1693	1275	1983	
United Kingdom	1238	1168	1360	1102	1234	1094	1192	1161	
Uzbekistan	0	0	0	0	0	0	0		
Non-EU	**12098**	**11188**	**12689**	**10172**	**10474**	**9975**	**9983**	**11160**	
Total	**33099**	**27432**	**29332**	**24905**	**24581**	**24517**	**23358**	**27336**	

Table 5: Acidification (% of ecosystem area exceeding critical loads), preliminary results

			Baseline		MTFR		LOW		GP compliant	
Country	Ecosystem area [km2	2015	2030	2050	2030	2050	2030	2050	2030	2050
Austria	38.901	0,6	0,0	0,0					0,0	
Belgium	15.482	42,1	32,4	28,9	30,1	22,9	27,8	15,4	32,4	
Bulgaria	54.242	0,0								
Croatia	36.341	3,3	0,5	0,3	0,1		0,1		0,5	
Cyprus	1.692									
Czech Rep.	23.831	77,8	19,4	5,4	5,7	0,2	5,4	0,0	16,1	
Denmark	6.657	13,5	1,6	0,6	0,6		0,3		1,2	
Estonia	30.583									
Finland	281	0,4	0,3	0,3	0,3	0,1	0,3	0,0	0,3	
France	176.852	5,5	2,1	1,2	0,8	0,0	0,2		2,1	
Germany	103.401	48,3	21,9	16,4	16,0	6,4	14,2	3,5	21,0	
Greece	77.626	0,6	0,1	0,1	0,1		0,1		0,1	
Hungary	29.969	5,8	2,6	1,8	1,5	0,0	0,3		2,4	
Ireland	16.195	1,1	0,6	0,4	0,3	0,1	0,2		0,4	
Italy	100.954	0,5	0,1	0,1	0,1	0,0	0,1	0,0	0,1	
Latvia	44.142	2,2	0,1		0,1				0,1	
Lithuania	26.331	24,0	14,3	8,6	4,8	0,4	3,2		11,9	
Luxembourg	1.376	13,6	1,3	0,7	0,4		0,4		1,1	
Malta	35									
Netherlands	2.755	72,4	71,2	70,5	70,8	68,9	70,4	56,9	71,2	
Poland	95.931	42,0	5,9	2,1	2,3	0,1	2,1	0,1	5,3	
Portugal	41.903	1,6	0,3	0,3	0,2	0,0	0,3	0,0	0,3	
Romania	109.259	0,8	0,2	0,0	0,0	0,0	0,0		0,1	
Slovakia	26.757	5,3	0,7	0,2	0,2		0,2		0,5	
Slovenia	14.052	0,0	0,0	0,0					0,0	
Spain	251.625	0,6	0,1	0,1	0,1	0,0	0,0		0,1	
Sweden	391.665	3,3	1,2	1,0	1,0	0,7	1,0	0,7	1,2	
EU-27	**1.718.839**	**9,1**	**3,2**	**2,1**	**2,0**	**0,9**	**1,7**	**0,6**	**3,0**	
Albania	19.947									
Armenia										
Azerbaijan										
Belarus	66.499	5,6	1,0	0,8	0,3	0,0	0,2		0,8	
Bosnia-H	36.959	11,1	1,1	0,6	0,1				1,1	
Georgia										
Iceland										
Kazakhstan										
Kosovo	4.693	7,0								
Kyrgyzstan										
North Macedonia	16.846	1,0								
R Moldova	3.773									
Montenegro	9.041									
Norway	320.380	9,4	4,9	3,6	3,8	1,9	3,6	1,3	4,6	
Russia	643.092	0,5	0,3	0,4	0,1	0,0	0,1	0,0	0,3	
Serbia	33.005	17,2	0,4	0,3	0,2	0,0	0,0		0,4	
Switzerland	9.733	16,4	11,4	10,6	10,5	7,7	9,3	3,1	11,0	
Tajikistan										
Türkiye										
Turkmenistan										
Ukraine	97.758	1,2	0,0	0,0	0,0		0,0		0,0	
United Kingdom	75.806	10,6	3,7	2,4	2,2	0,8	1,8	0,1	3,4	
Uzbekistan										
Non-EU	**1.337.532**	**4,4**	**1,7**	**1,3**	**1,2**	**0,6**	**1,1**	**0,3**	**1,6**	
Total	**3.056.371**	**7,0**	**2,5**	**1,8**	**1,6**	**0,7**	**1,4**	**0,5**	**2,4**	

Table 6: Eutrophication (% of ecosystem area exceeding critical loads), preliminary results



			Baseline		MTFR		LOW		GP compliant	
Country	Ecosystem area [km2]	2015	2030	2050	2030	2050	2030	2050	2030	2050
Austria	50.489	65,1	42,6	35,4	28,4	12,5	24,9	1,3	37,4	
Belgium	15.552	65,7	53,0	45,4	50,1	41,1	45,0	29,6	52,0	
Bulgaria	54.322	85,6	72,3	67,1	57,3	39,5	51,6	33,6	71,2	
Croatia	36.411	90,5	79,5	77,1	73,7	61,5	73,5	46,4	78,7	
Cyprus	1.691	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	
Czech Rep.	23.831	96,8	81,5	71,0	69,7	35,7	68,6	5,1	80,1	
Denmark	6.665	100,0	99,7	99,2	99,5	96,7	99,2	63,1	99,6	
Estonia	30.592	46,4	33,4	30,1	29,5	17,7	28,7	10,7	31,3	
Finland	41.047	10,6	2,5	0,9	1,4	0,0	1,2		2,2	
France	176.937	83,5	66,4	61,2	57,3	41,8	51,3	11,2	65,9	
Germany	103.988	79,8	68,0	62,3	61,9	46,3	59,0	27,1	67,2	
Greece	77.844	100,0	99,9	99,9	99,9	99,7	99,9	98,8	99,9	
Hungary	30.007	91,2	73,8	70,1	68,8	64,0	67,9	48,6	71,5	
Ireland	16.776	48,2	44,8	42,8	40,4	32,8	33,6	4,3	42,3	
Italy	105.815	71,5	50,0	45,6	42,5	30,0	41,9	17,8	48,8	
Latvia	44.159	91,4	72,6	60,3	58,8	42,4	53,8	38,2	70,2	
Lithuania	26.352	99,0	97,3	94,2	93,1	68,9	89,9	38,4	97,0	
Luxembourg	1.377	100,0	100,0	98,8	97,2	90,1	96,4	54,4	100,0	
Malta	35	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	
Netherlands	2.976	87,8	77,5	72,2	75,5	57,7	66,2	20,7	77,5	
Poland	95.929	75,8	59,6	50,2	46,8	20,4	47,0	6,8	57,7	
Portugal	42.008	84,2	70,5	69,2	64,3	58,8	64,7	56,7	70,1	
Romania	109.333	93,9	90,4	86,4	83,2	67,6	79,3	43,6	90,1	
Slovakia	26.799	96,2	86,9	84,0	82,7	59,5	79,9	32,2	86,4	
Slovenia	14.066	86,1	62,1	57,0	54,9	38,2	52,4	25,2	60,5	
Spain	251.922	95,2	90,4	89,1	85,4	78,3	84,7	72,9	90,0	
Sweden	58.643	14,3	12,5	11,3	11,5	4,8	11,2	2,4	12,5	
EU-27	**1.445.569**	**80,2**	**69,2**	**65,0**	**62,2**	**49,4**	**60,0**	**35,5**	**68,2**	
Albania	19.971	92,9	89,5	89,5	85,1	77,7	85,7	74,9	89,4	
Armenia										
Azerbaijan										
Belarus	66.500	100,0	99,8	99,8	98,4	89,1	96,6	46,0	99,8	
Bosnia-H	37.044	74,5	70,5	69,3	66,6	57,6	65,6	50,4	70,2	
Georgia										
Iceland										
Kazakhstan										
Kosovo	4.703	83,9	69,0	66,5	51,7	38,5	39,5	18,5	67,8	
Kyrgyzstan										
North Macedonia	16.892	83,0	71,2	69,1	63,0	55,1	58,2	51,2	71,1	
R Moldova	3.774	99,8	98,4	98,4	80,6	65,0	76,8	52,5	98,4	
Montenegro	9.059	60,6	52,9	48,8	43,5	36,1	36,7	32,1	52,5	
Norway	303.446	11,9	7,2	5,4	5,4	2,0	4,9	0,4	6,9	
Russia	643.119	50,4	44,1	42,2	33,0	12,1	28,7	5,6	43,9	
Serbia	33.064	91,4	86,1	84,0	78,3	64,1	67,2	42,1	85,8	
Switzerland	24.248	57,6	48,4	45,0	44,4	35,1	40,3	13,0	46,2	
Tajikistan										
Türkiye										
Turkmenistan										
Ukraine	97.773	100,0	100,0	99,9	99,4	96,0	98,8	73,1	99,9	
United Kingdom	71.070	25,6	15,4	11,4	11,1	3,9	9,0	0,4	14,7	
Uzbekistan										
Non-EU	**1.330.663**	**49,6**	**44,2**	**42,5**	**37,4**	**24,3**	**34,4**	**15,4**	**44,0**	
Total	**2.776.232**	**65,6**	**57,2**	**54,2**	**50,3**	**37,4**	**47,7**	**25,9**	**56,6**	