International Institute for Applied Systems Analysis
IIASA www.iiasa.ac.at

Towards scenarios supporting policy development under the Convention

Z. Klimont, G. Kiesewetter, C. Heyes, L. Hoglund-Isaksson, P. Rafaj, K. Kaltenegger, W. Winiwarter, L. Warnecke, F. Wagner, A. Gomez-Sanabria, J. Borken-Kleefeld, M. Posch, Y. Kim, R. Sander, B. Nguyen

CIAM/IIASA

TFIAM 52 meeting, 24-26 May 2023
Utrecht, NL

Contents

- Status of methodological improvements and extensions in GAINS
- Third EU Clean Air Outlook
- Future reduction goals and their feasibility, target setting – initial thoughts
- Further development of methane scenarios

Methodological improvements/extensions in GAINS

RECENTLY IMPLEMENTED (2022):

Soil NOx, NMVOC from livestock manures and crop production, new waste management module, Mercury, update of critical loads database *(jointly with CCE),* new source receptor (SR) coefficients *(jointly with MSC-W),* extended domain (including all EECCA), representation of condensables *(jointly with TNO, MSC-W, NILU)*

Methodological improvements/extensions in GAINS

FURTHER DEVELOPMENTS(2023-2024):

- Improvements of spatial representation of emissions *(jointly with MSC-W, CEIP)*,
- Update of technology parameterization in GAINS *(jointly with TFTEI) and* model structure to, e.g., better represent hydrogen economy, new fuels like ammoia, new technologies, e.g., slurry acidification,
- NMVOC speciation (technology specific),
- Update of ozone in GAINS *(jointly with MSC-W)*,
- Potential updates for health and ecosystem impact assessments *(under discussion, coordinated with TFH),*
- Improved tepresentation of urban scale *(jointly with MSC-W)*

The Clean Air Outlook (CAO)

- Series of reports outlining possible future emissions and health/environmental impacts from air pollution in the EU
- Review progress and likely attainment of National Emission Reduction Commitments (NEC directive)
- 3rd Clean Air Outlook was published in December 2022; COM (2022) 673 and IIASA Support Study, available online https://environment.ec.europa.eu/topics/air/clean-air-outlook_en
- The analysed emission scenarios were updated from the AAQD* Impact Assessment
  - consultations with Member States to discuss emissions and implementation of policies
  - systematic update of soil NOx emissions from agriculture
  - proposal for revision of the IED for agriculture is included in CAO3
- Expanded beyond the set of scenarios analysed for AAQD Impact Assessment

*AAQD – Ambient Air Quality Directive; the baseline for GP review is similar to AAQD baseline

3rd Clean Air Outlook vs GP review scenarios

- Starting from AAQD baseline, three scenarios were developed for GP review in 2022 (Baseline, MTFR, Low)

- CAO3 baseline for EU27 differs from GP review *Baseline* mostly for NH_3 because of inclusion of IED proposal in CAO3. For other species the differences are within less than 5% at the EU27 level

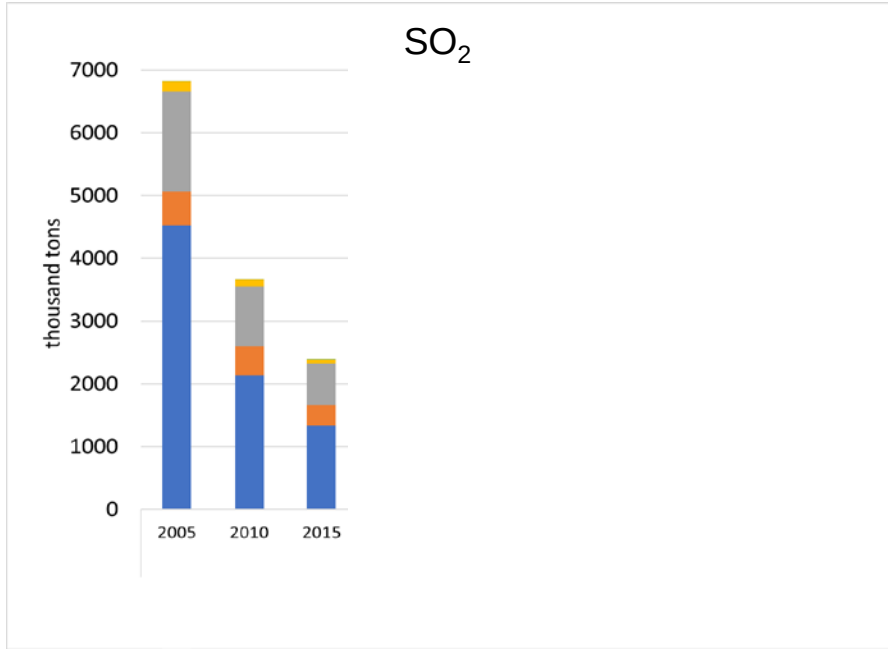
- Overall mitigation potential in CAO3 similar (within ∓10%) to GP review *MTFR* and *Low* scenarios, although in the long term (2050) NH_3 reduction in the *Low* case is greater by nearly 20% compared to the *Flexitarian* scenario in CAO3

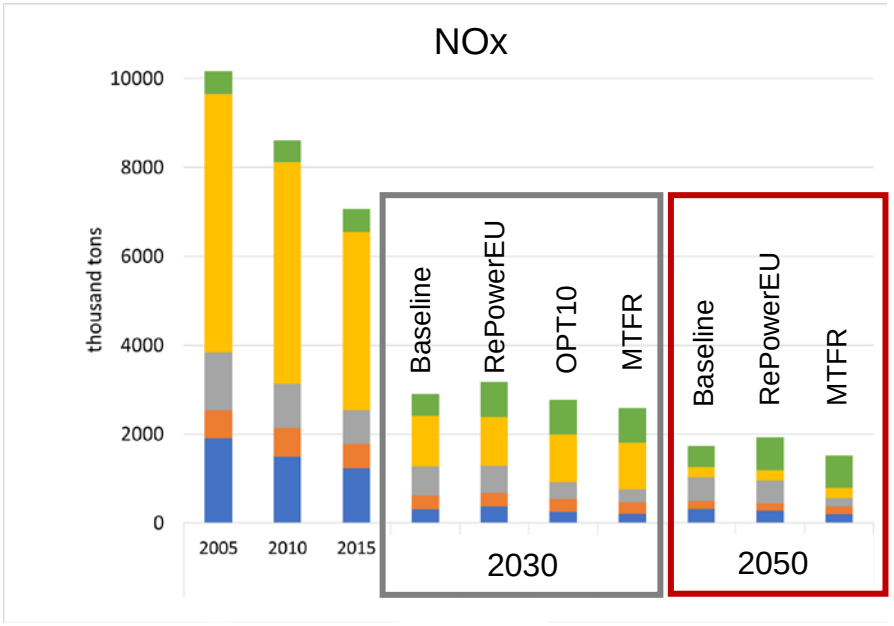
- The scenarios are not yet available in the GAINS online model; pending permission of the Commission to release MS level data

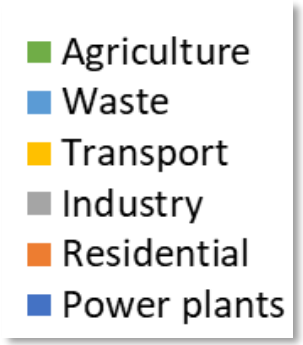
CAO3 Scenarios

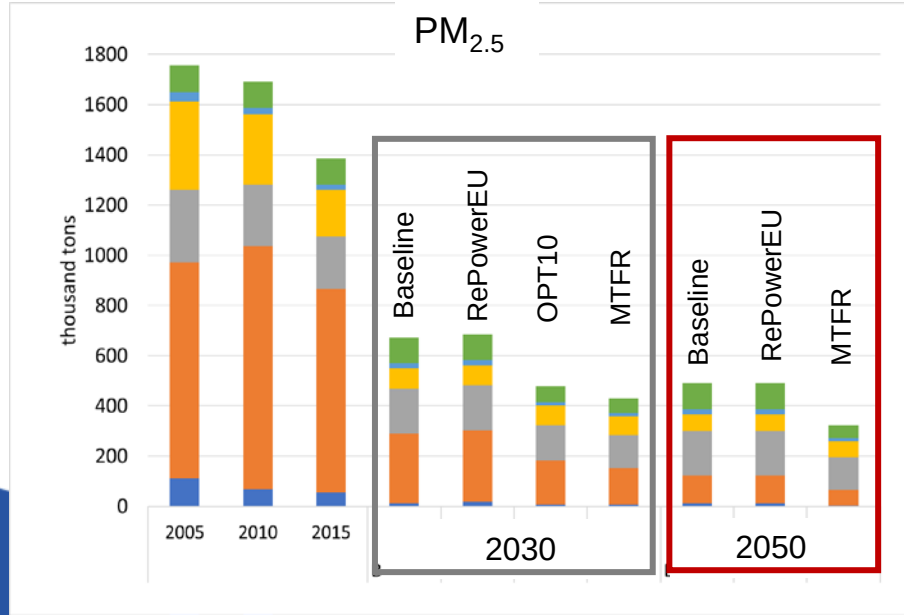
- Baseline
  - Review of the recent policies and measures and national implementation progress and plans
  - Energy, industry, and agriculture for the EU – Green Deal (Fit for 55)
- Alternative baseline: RePowerEU
  - Changed energy pathway due to war in Ukraine (reduced reliance on gas, extended use of solid fuels)
- Cost-optimal scenario targeting 10 µg/m^3 (AAQD proposal)
- Maximum technically feasible reductions (MTFR)
  - Best available emission control technologies are applied to the extent possible (irrespective of costs)
- FlexDiet
  - Dietary shifts towards less meat consumption
  - Reduced livestock numbers but not mineral fertilizer use

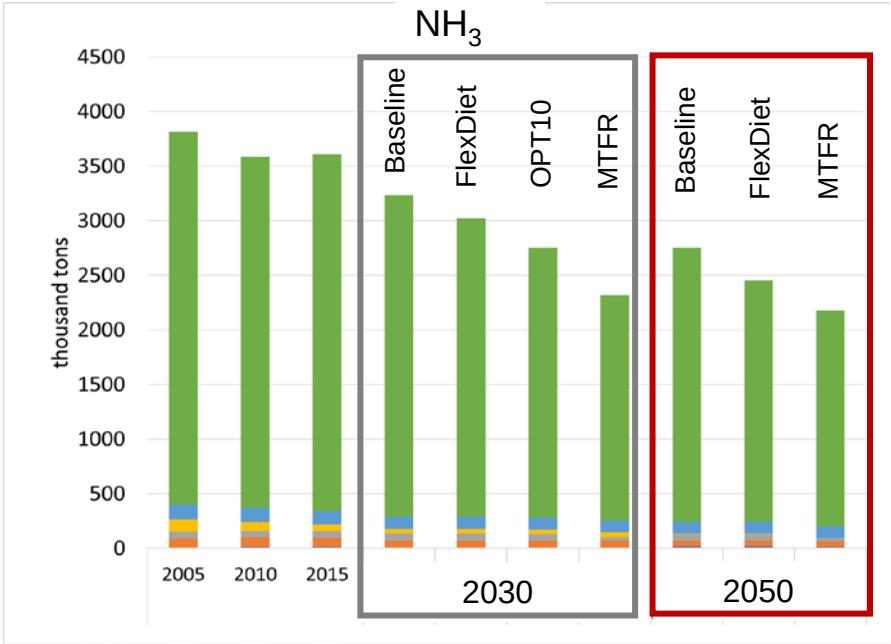
CAO3 emission projections for EU27





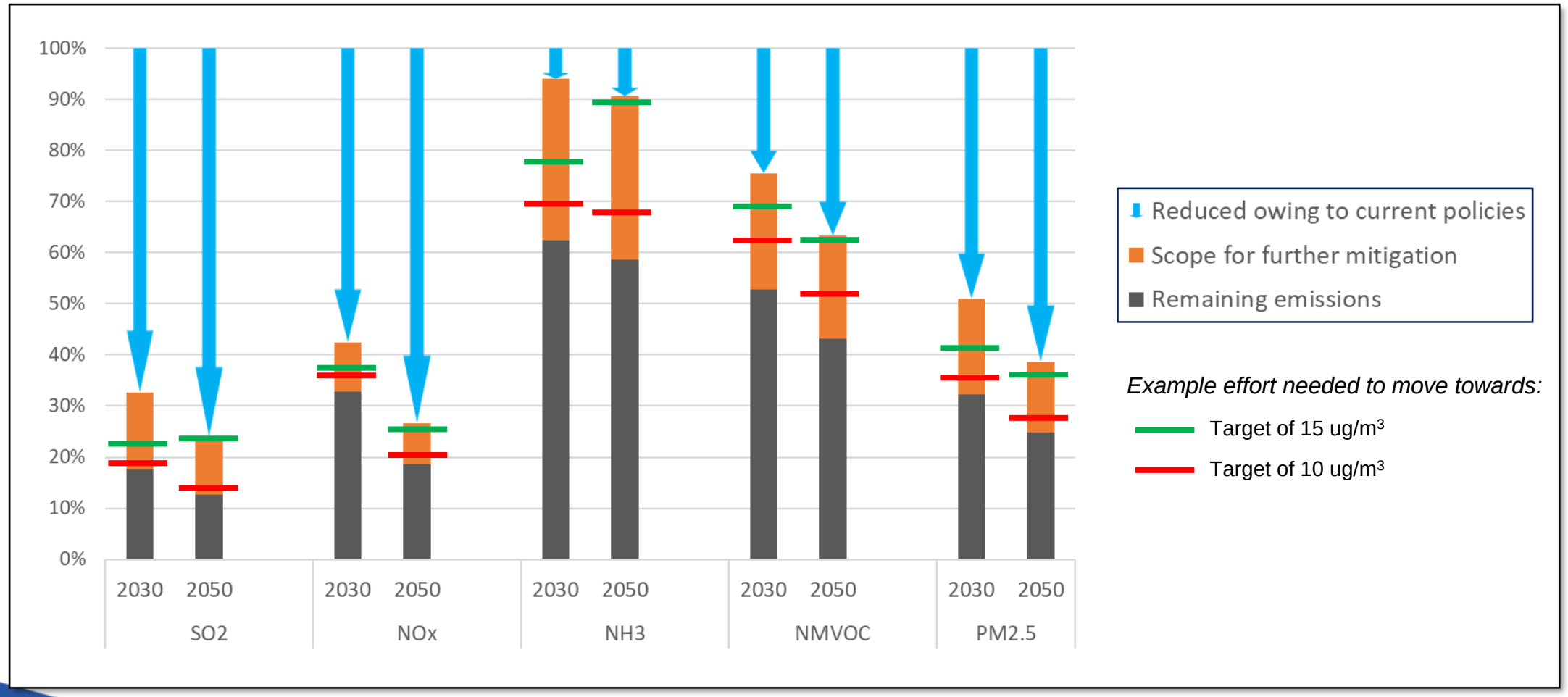






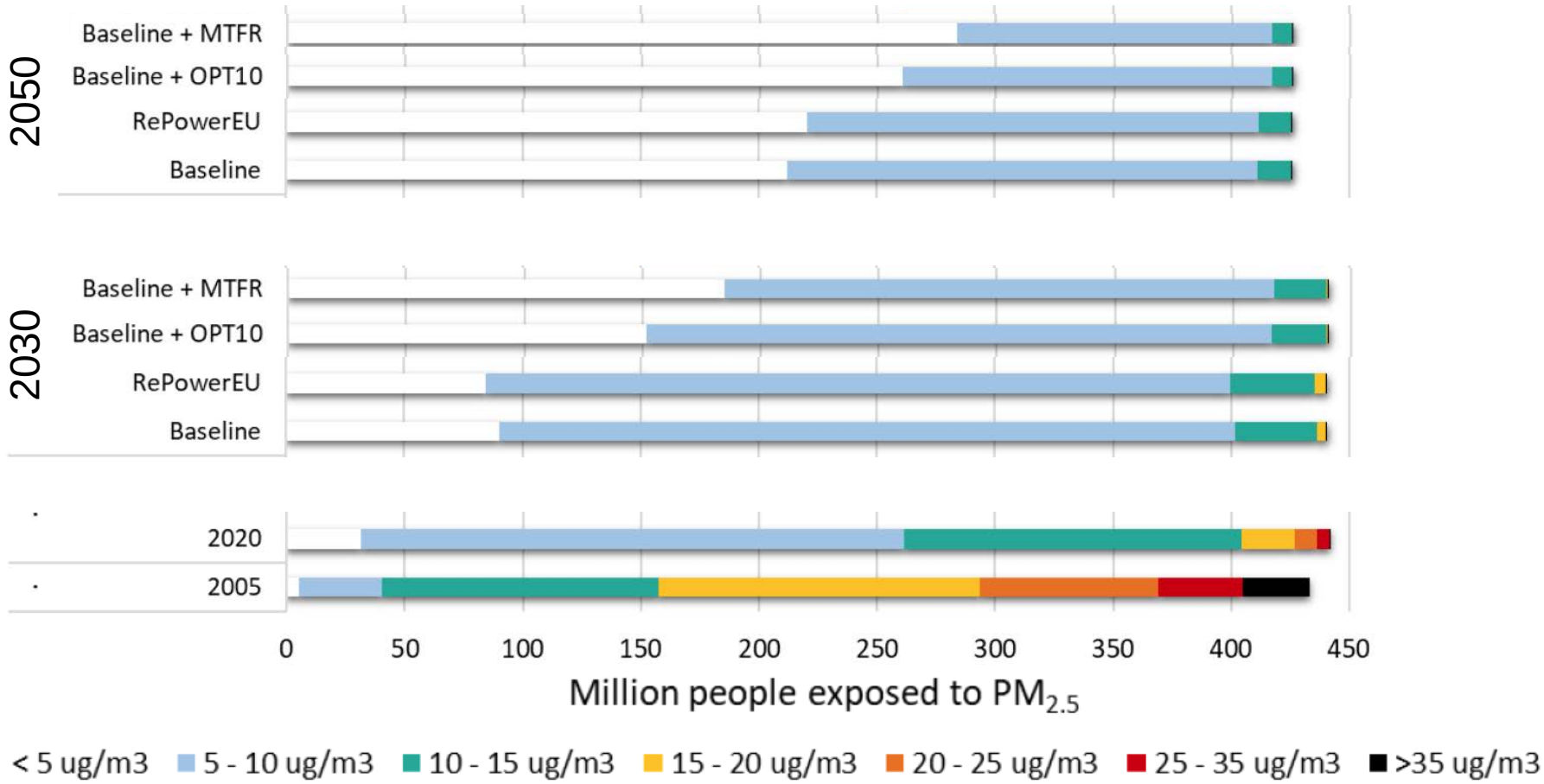
Emission trends (scope for further reductions; EU-27)*

- Current policies are expected to deliver significant further reductions, except ammonia (NH_3)
- Further mitigation potential exists and varies across pollutants and regions (not shown)



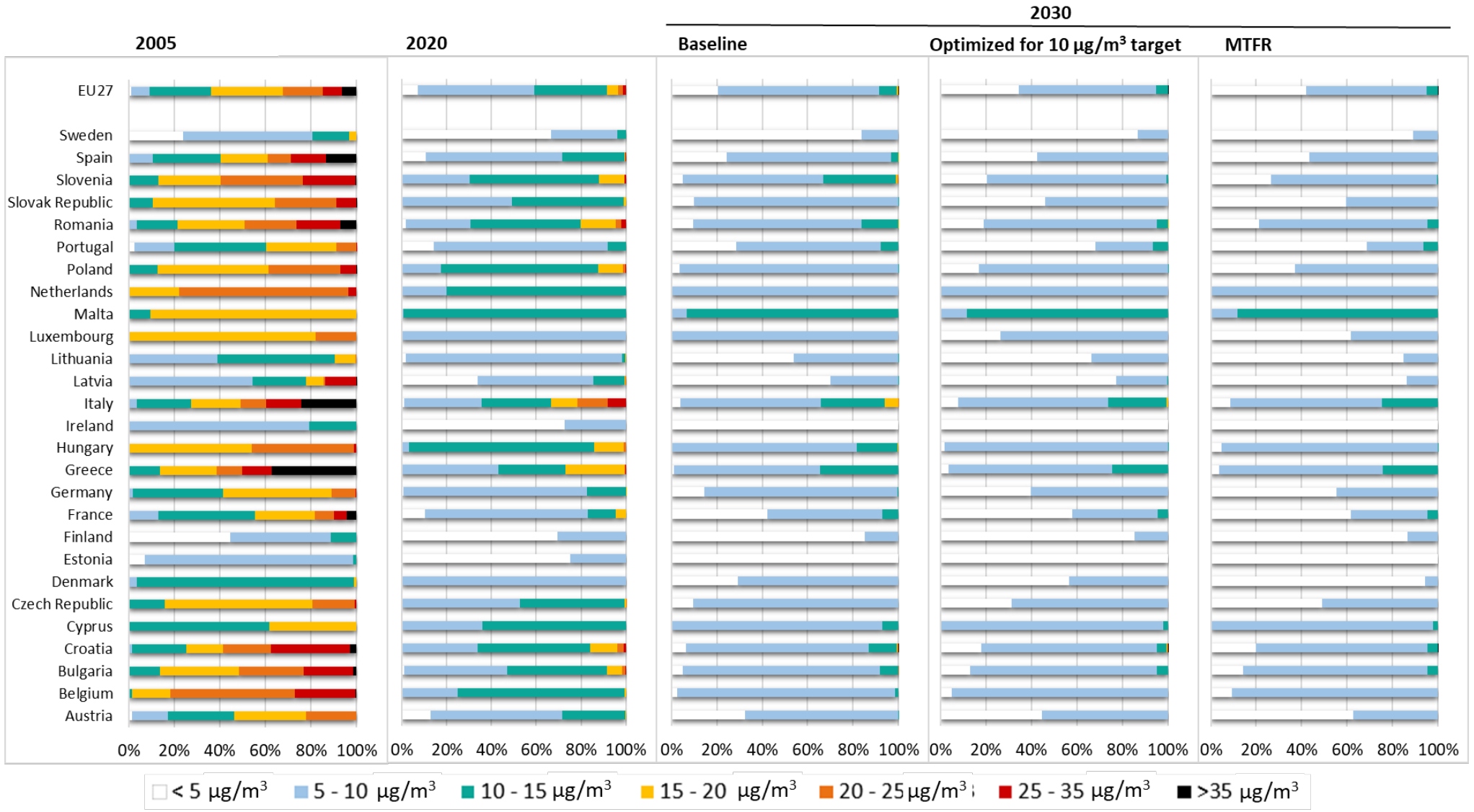
* GAINS model results from the impact assessment of revision of the Ambient Air Quality Directive

Population exposure to $PM_{2.5}$ for key* scenarios (EU27)



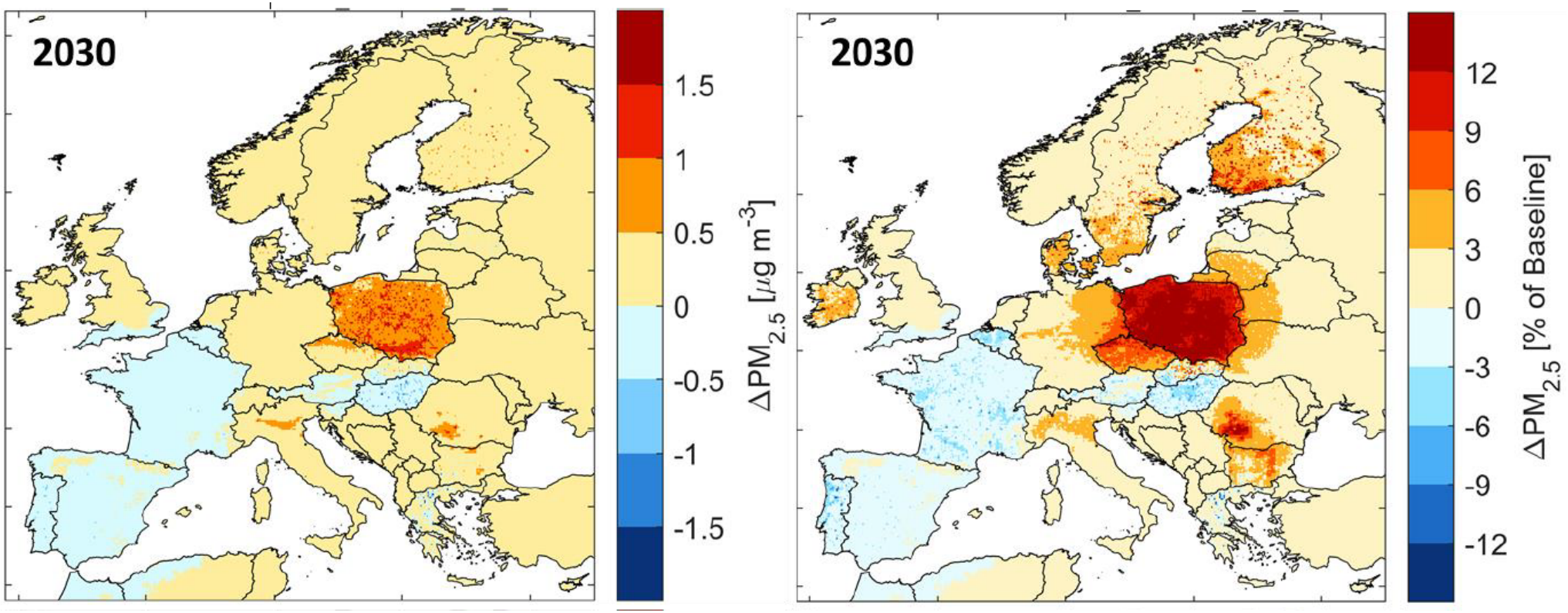
*Results for further scenarios, and at the MS level, available in the analysis supporting Commission report (see CAO website)

Population exposure to $PM_{2.5}$ for selected* scenarios (EU27)

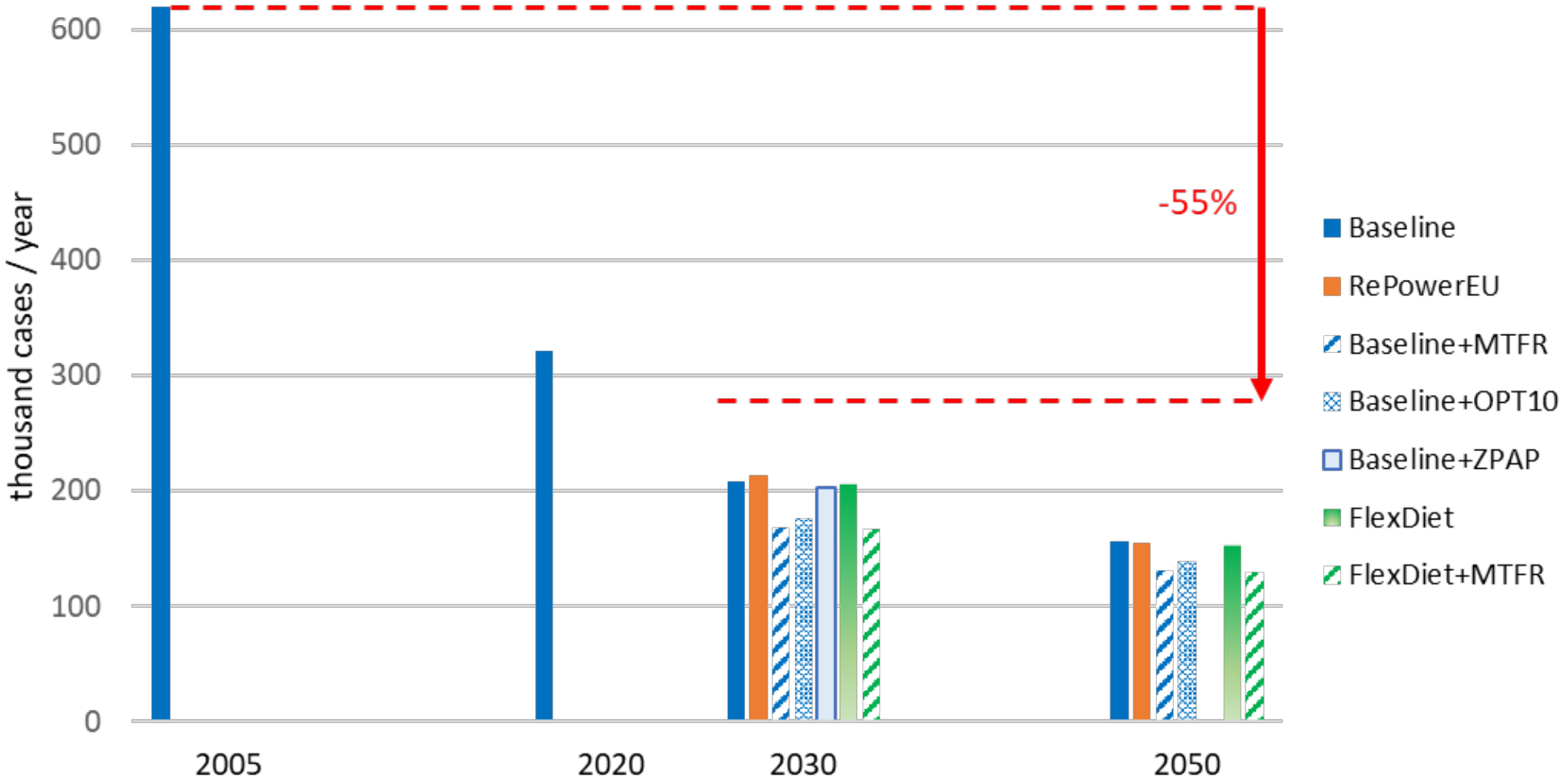


*Results for further scenarios available in the analysis supporting Commission report (see CAO website)

Difference in $PM_{2.5}$ due to *RePowerEU* vs *Baseline*

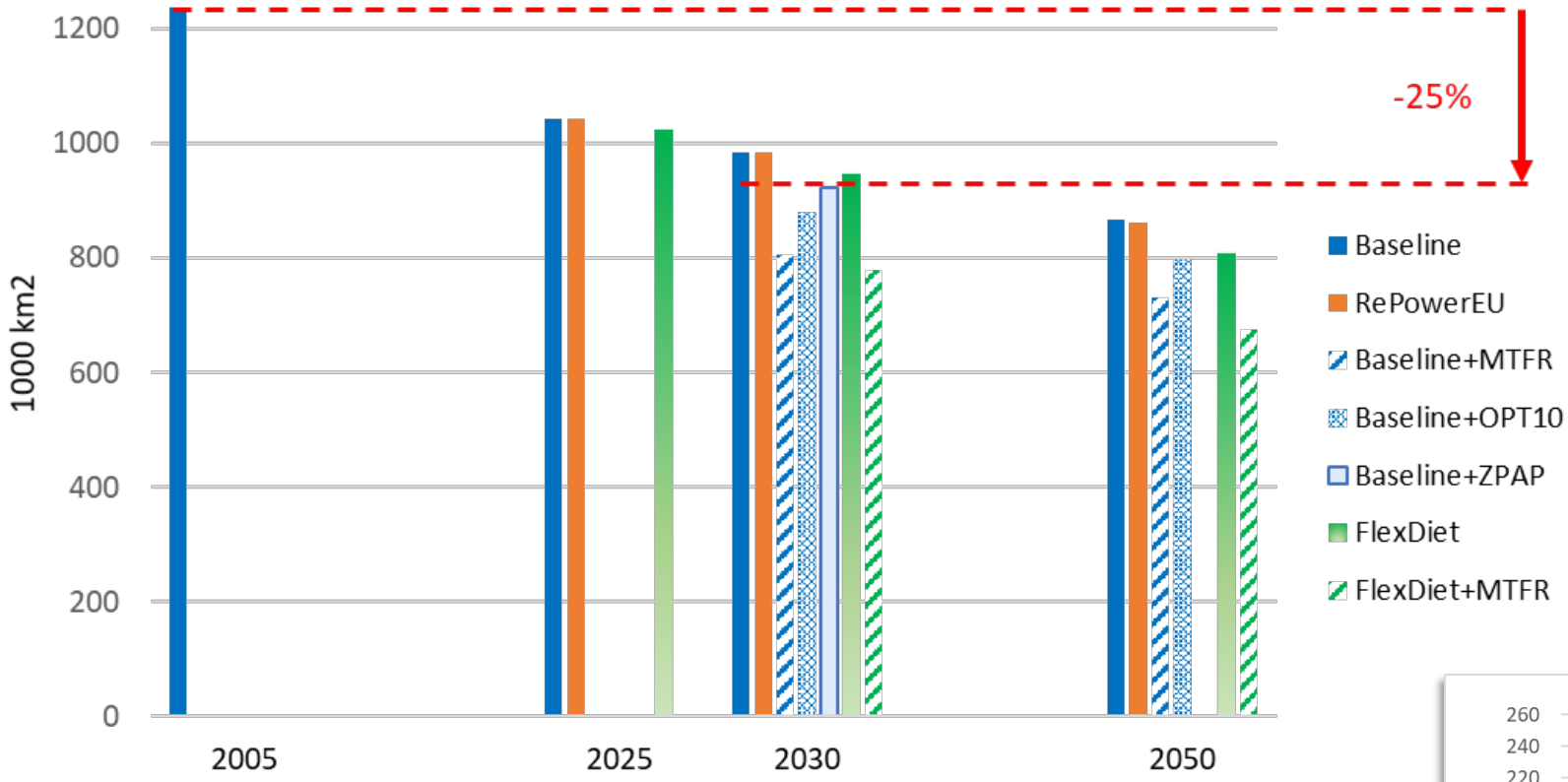


Health impacts $PM_{2.5}$ – mortality; anthropogenic sources



Concentration-response functions: Chen & Hoek (2020)

Impact on ecosystems

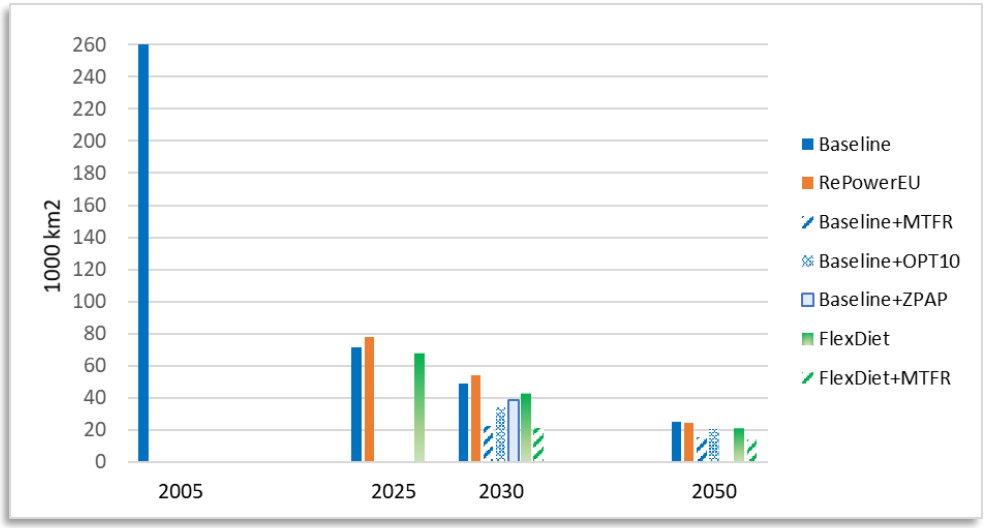


Eutrophication

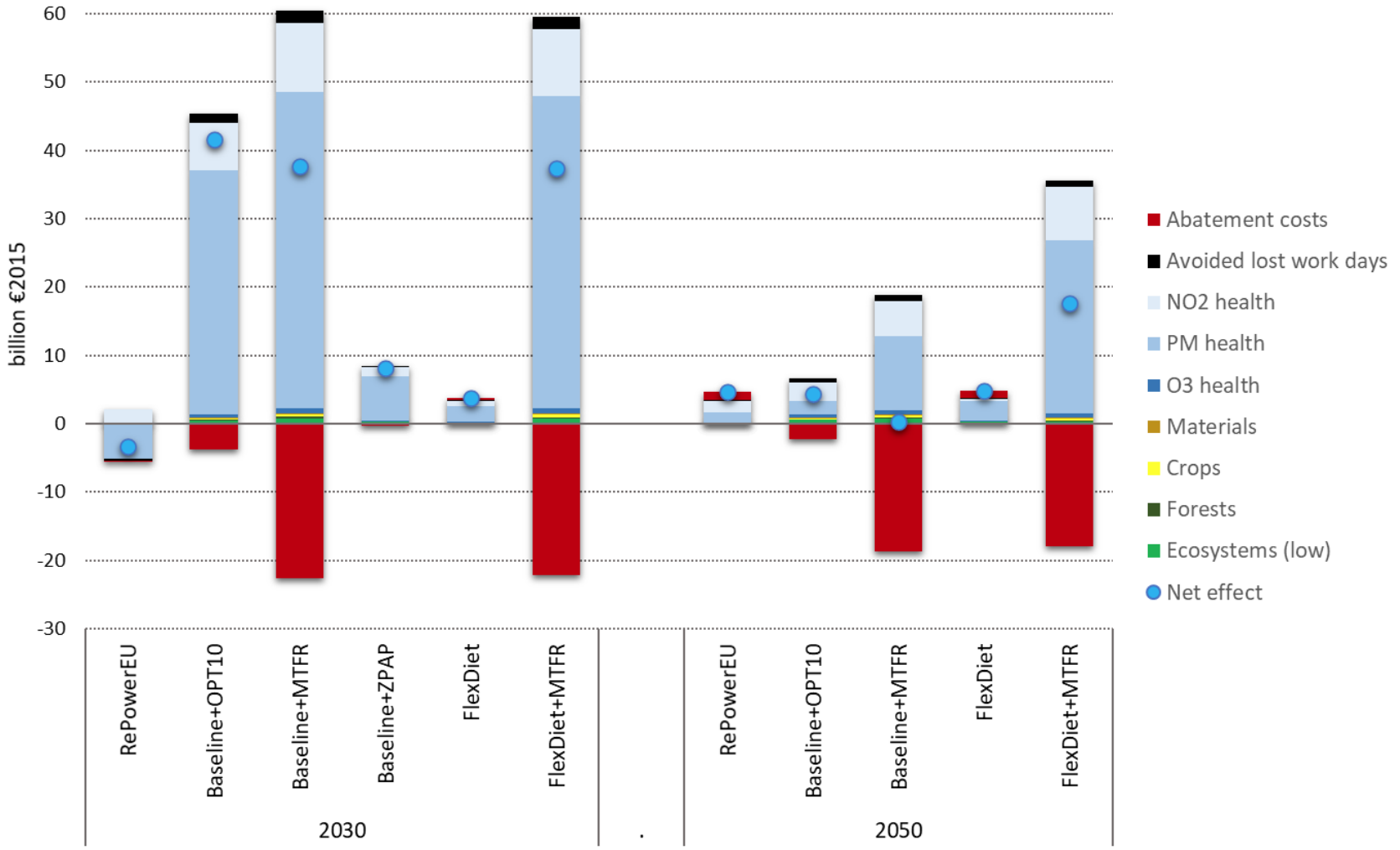
- ZPAP target not achieved in *Baseline,*
- Most countries not in compliance with NECD NH_3 targets, in spite of considetratino of revised IED
- Mitigation potential exists
- Flexitarian scenario impact larger in 2050

Acidification

- Strong decline of excess deposition since 2005
- *RePowerEU* leads to short term increase in deposition of S, N, compared to *Baseline*

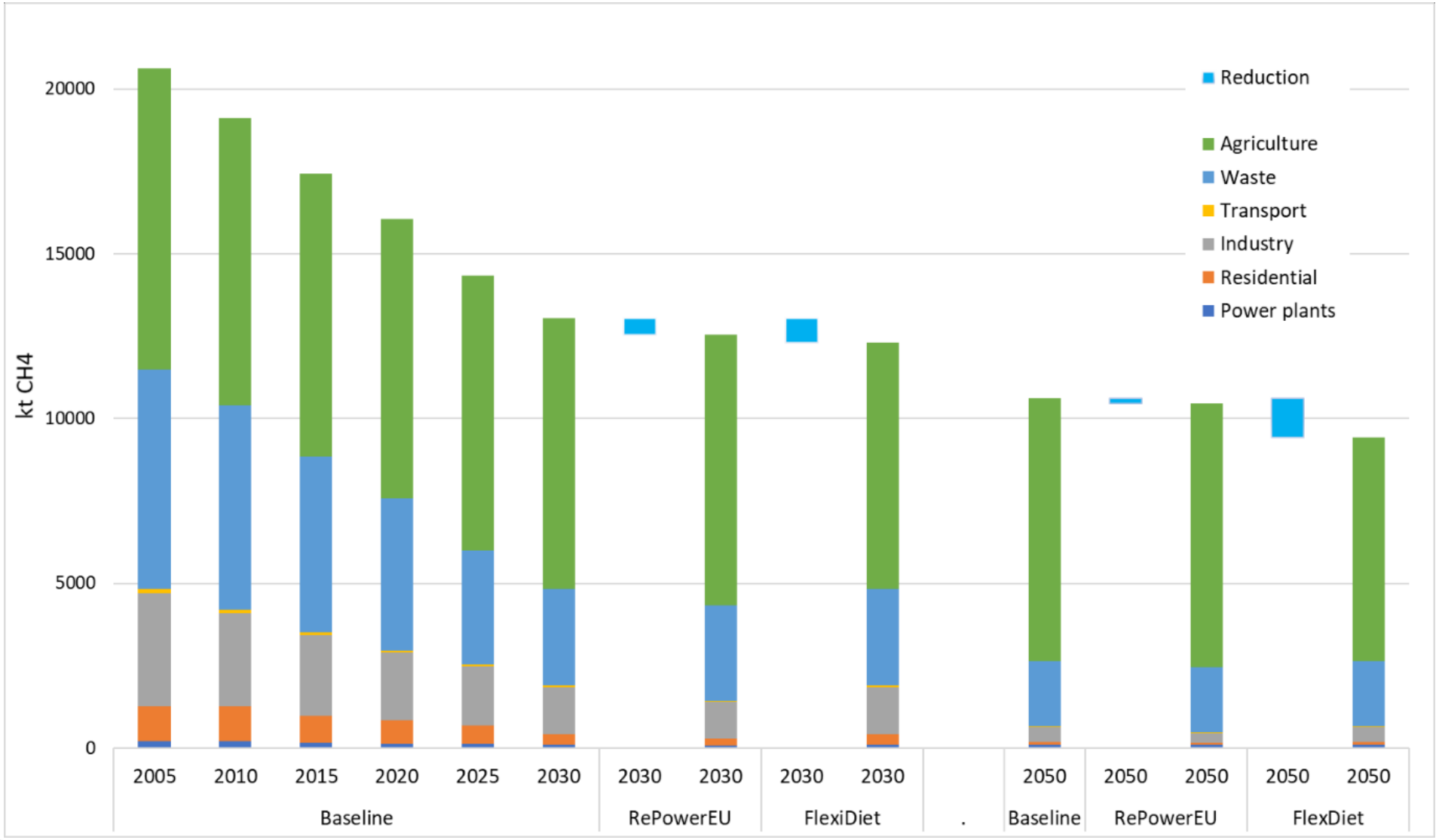


Cost-benefit analysis

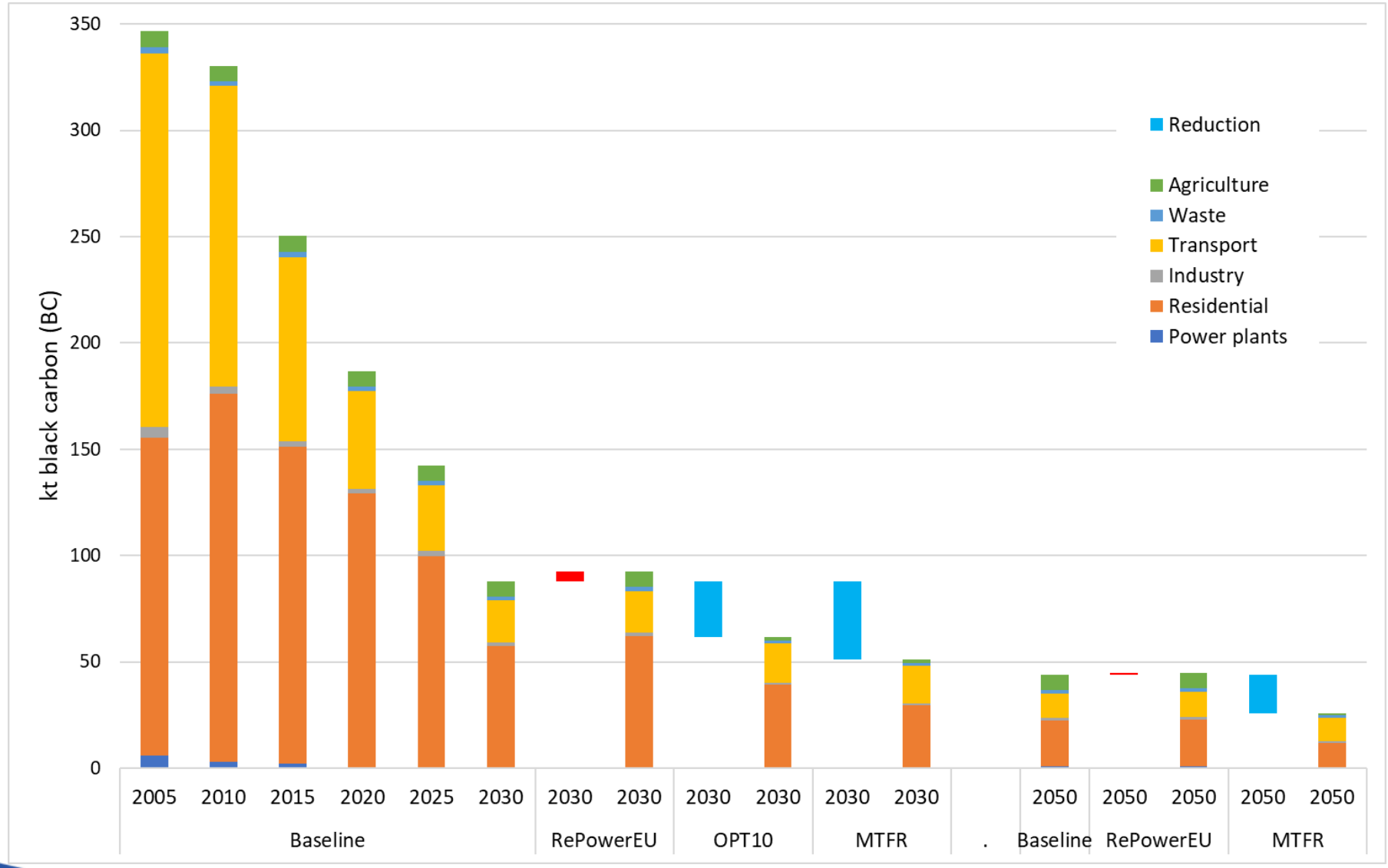


* only ambient air pollution included in benefits analysis – not dietary benefits

Co-Dis-Benefits
Methane emissions in selected scenarios for the EU27



Co-Dis-Benefits
Black carbon emissions in selected scenarios for the EU27



Summary

- Scenarios developed for the third Clean Air Outlook are updated from the AAQD Impact Assessment (and GP review scenarios) and explore a few more variants
- ***Baseline***: Substantial decreases of emissions. But WHO Guideline exceeded in large areas
- ***RePowerEU***: Slightly higher than *Baseline* due to increased and/or slower decline in use of solid fuels (primarily coal)
- Potential exists for mitigation through technical measures:
  - ***OPT10*** aims to achieve the proposed $PM_{2.5}$ limit value in a cost-optimal way
  - The ***MTFR* scenario** explores full implementation of all available technical measures
- National-level technical measures may not be enough to achieve the proposed limit values everywhere – local measures needed in hot spot areas (and/or behavioural changes)
- There are clear health and ecosystem benefits of further mitigation which outweigh the costs

Reducing health impacts due to PM

First thoughts on the "Peringe Grennfelt question"

Ideas for new targets...

- One of the recommendations from the Saltsjobaden 2023 Workshop:

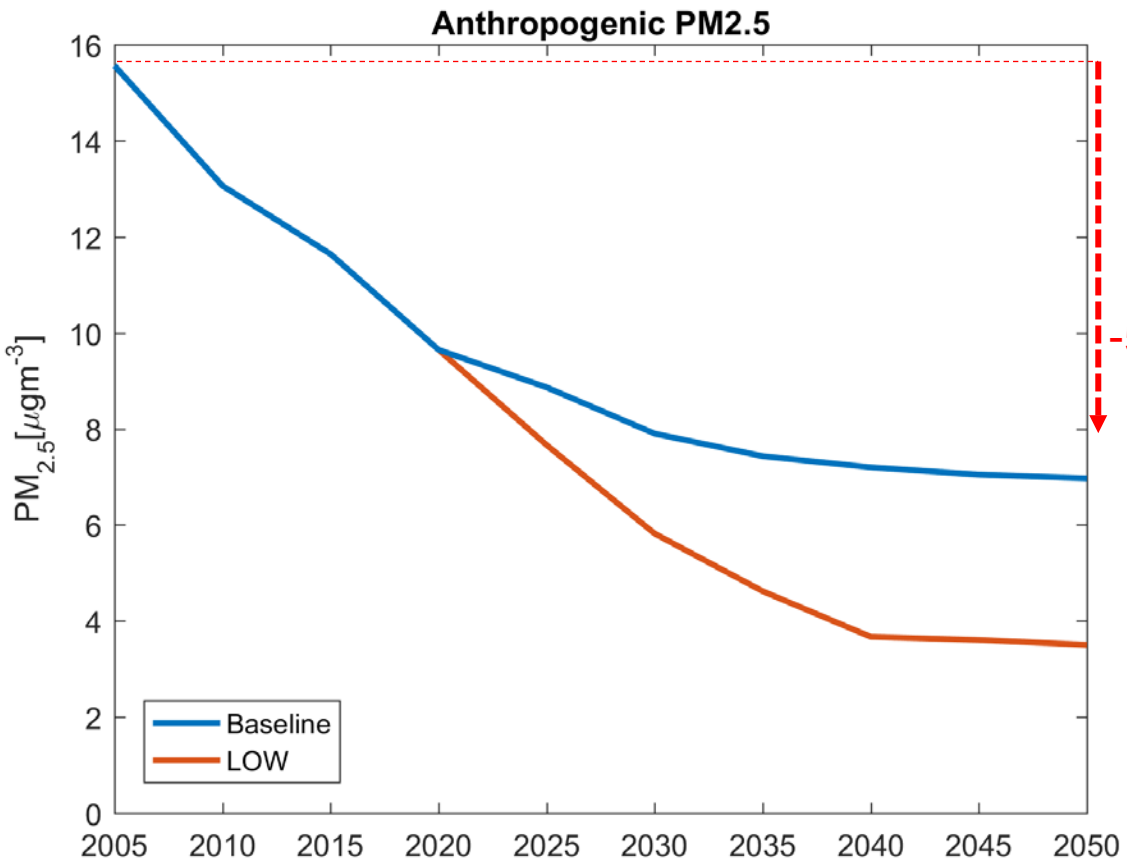
  Define a target for reduction of mortality from $PM_{2.5}$ by 50% by 2035.

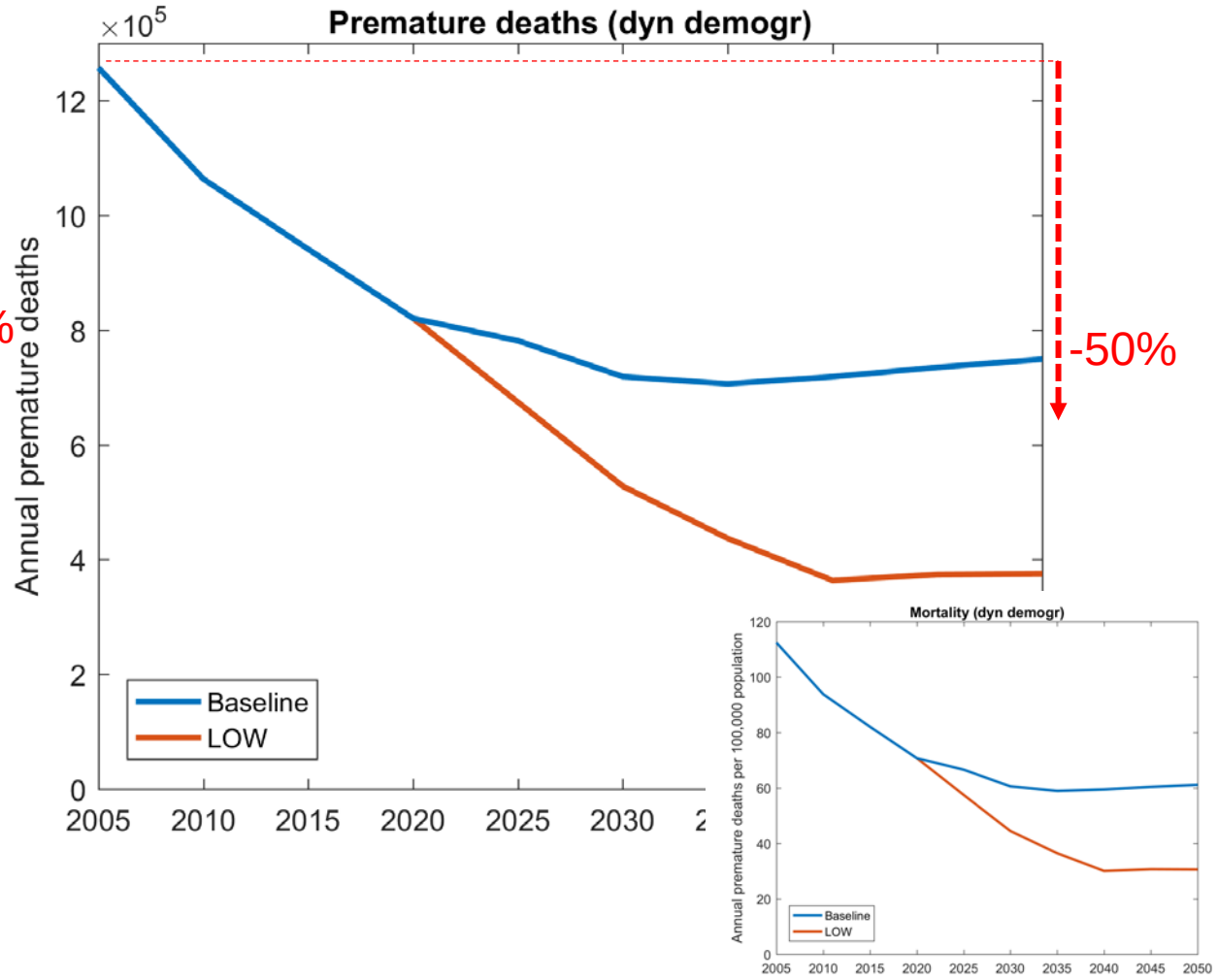
- Is this feasible for example in the UNECE region?
  - Depends where
  - Depends on the base year chosen
  - Depends on exact indicator (attributable deaths? Per 100k?)
  - Depends on health impact calculation methodology (linear CRF? Including natural PM? Cutoff? Dynamic demography?)

- Target ambition
  - For a region?
  - For a country?
  - For a country with additional city targets?
  - …

Scope for further mitigation in the UNECE region

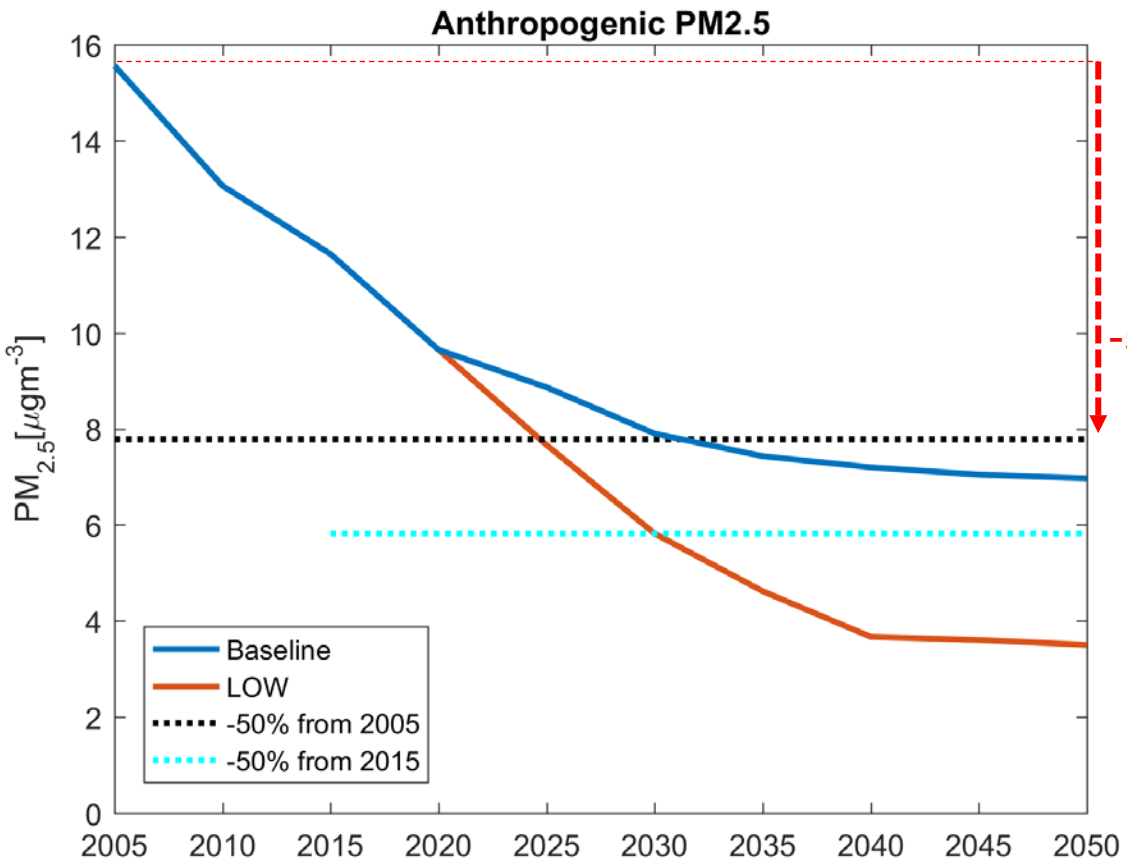
Exploring attainability of health improvement 'goals'

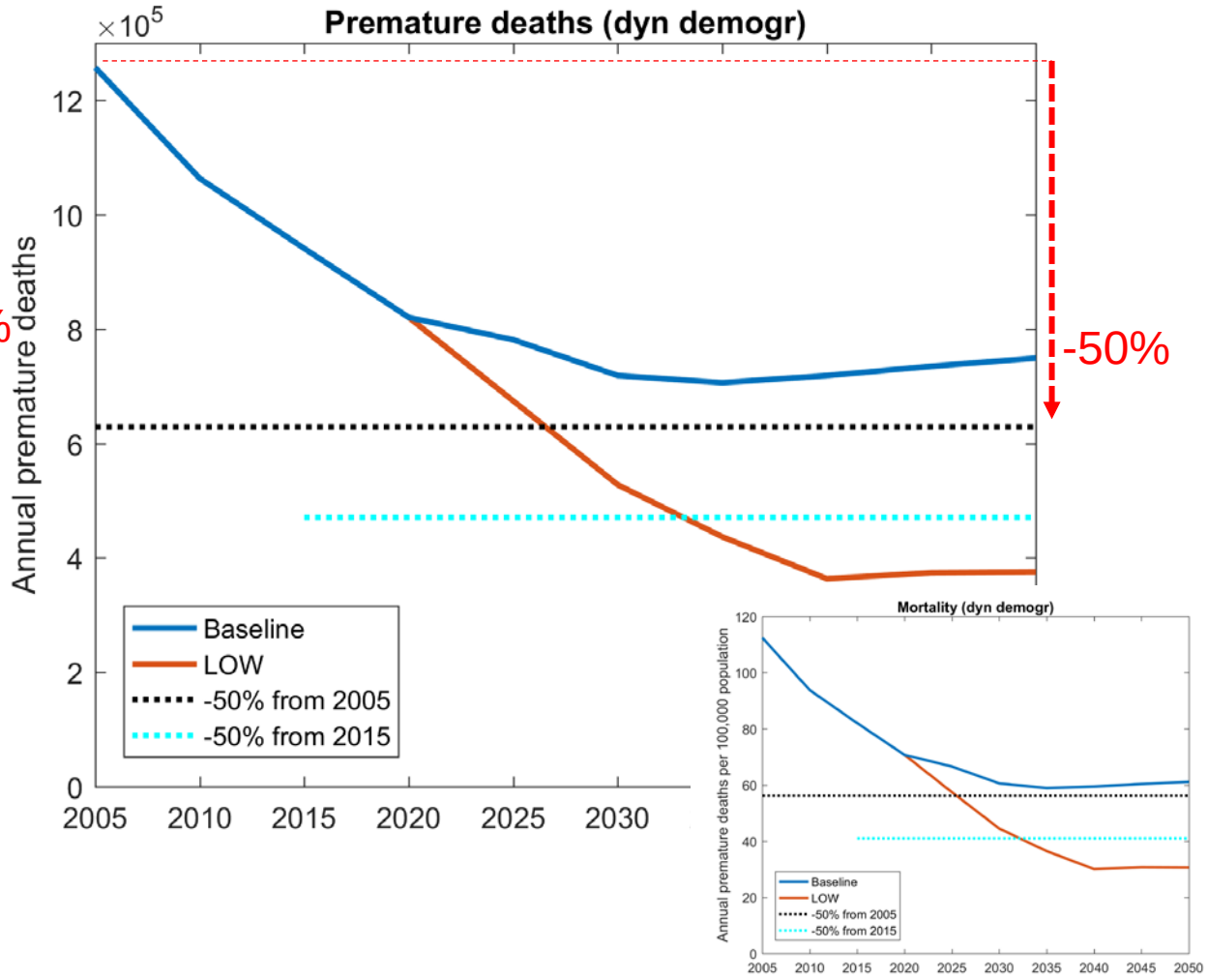




Scope for further mitigation in the UNECE region

Exploring attainability of health improvement 'goals'

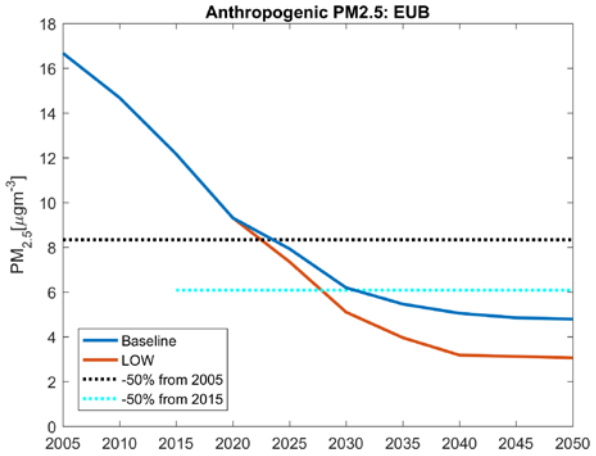


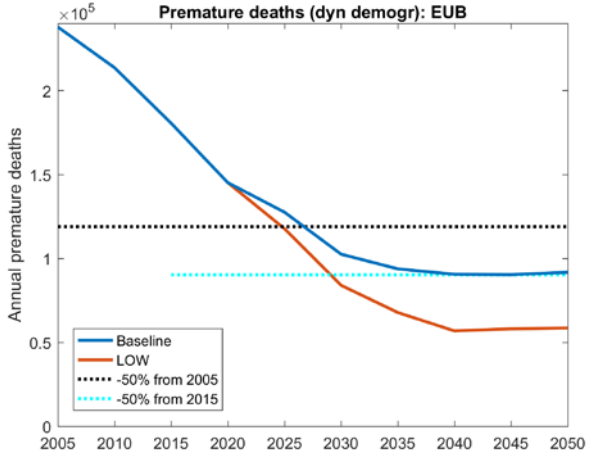


Scope for further mitigation in the UNECE region (2)

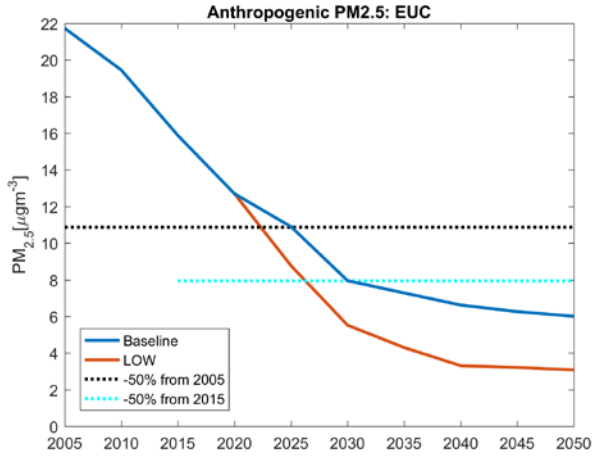
Exploring attainability of health improvement 'goals'

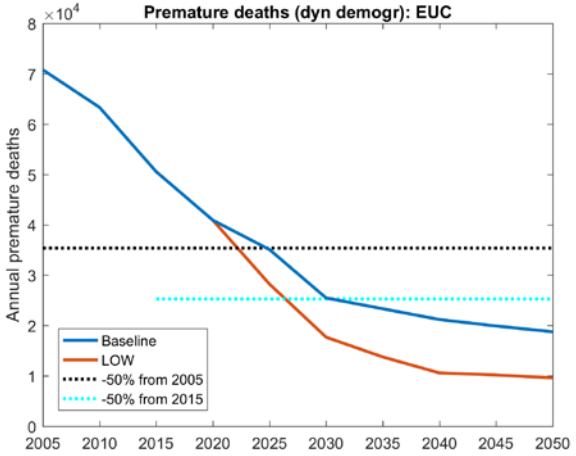
European Union (excluding group 2 + UK)



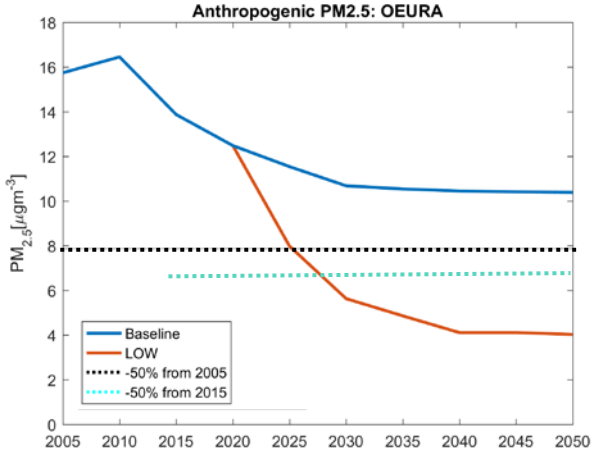


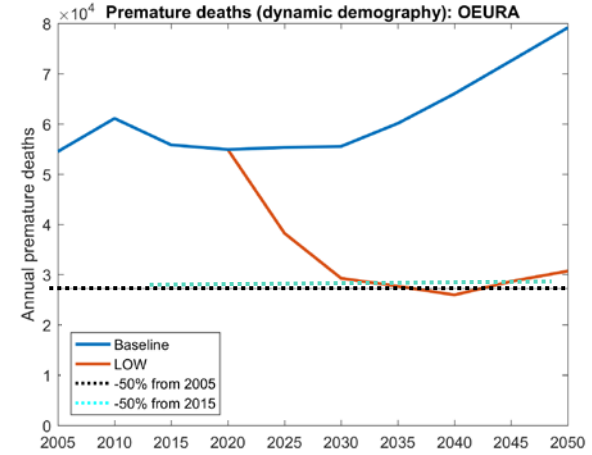
European Union (group 2 – BG, HR, CY, MT, RO)



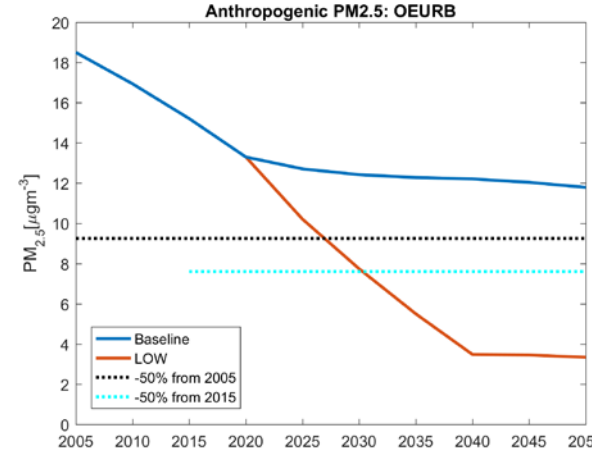


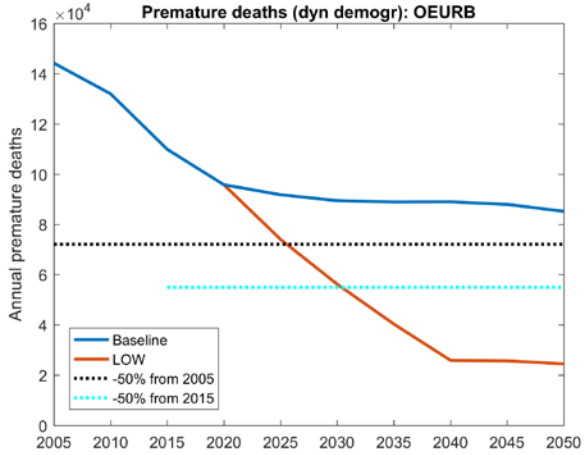
Türkiye (also IS, NO, CH, IL)





West Balkan, Ukraine, Belarus

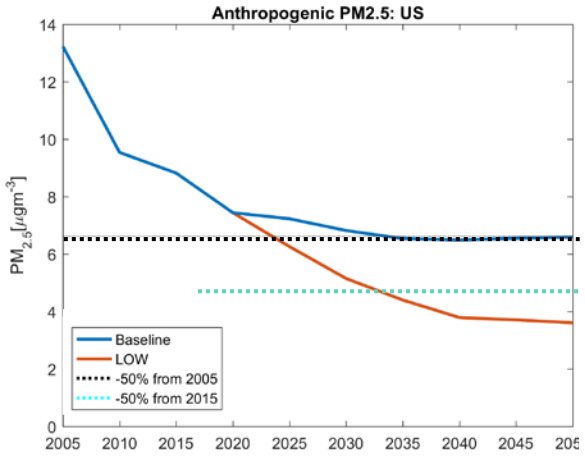


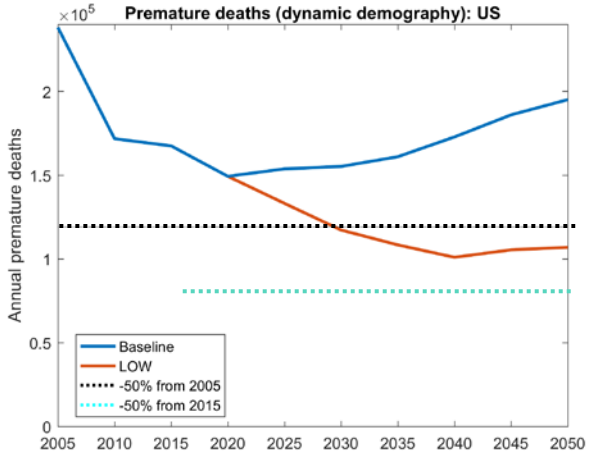


Scope for further mitigation in the UNECE region (3)

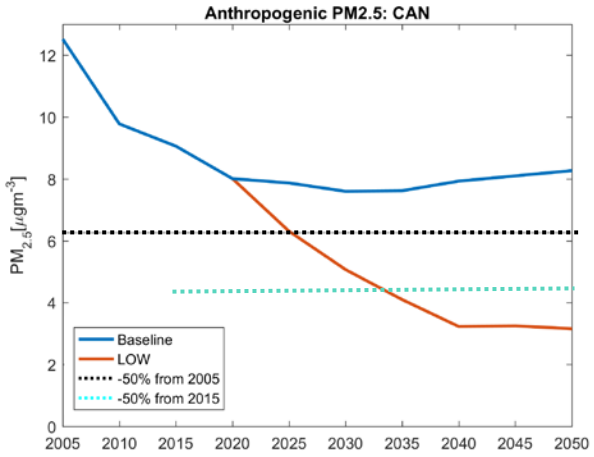
Exploring attainability of health improvement 'goals'

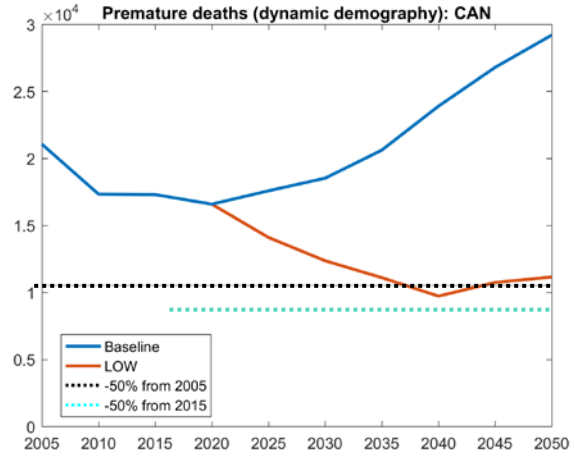
United States



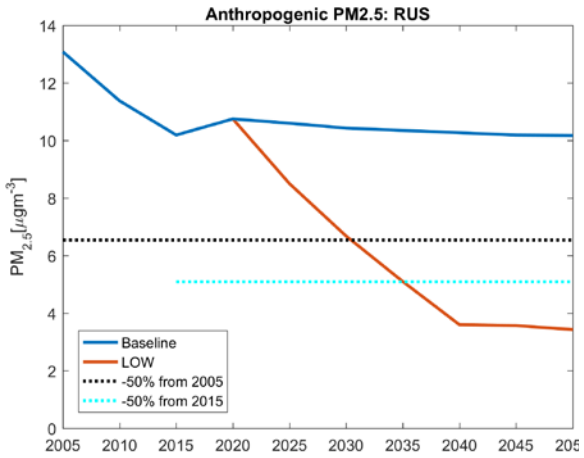


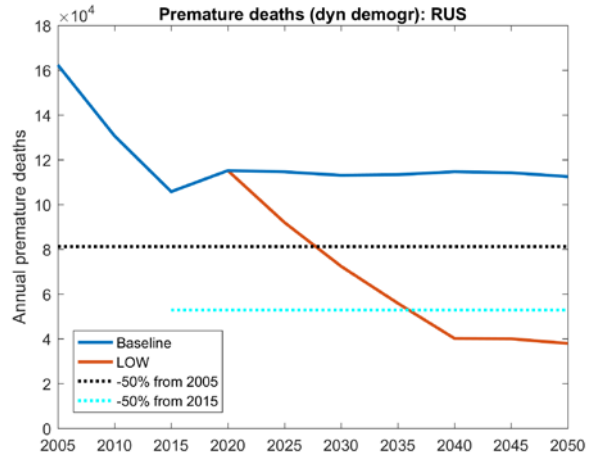
Canada



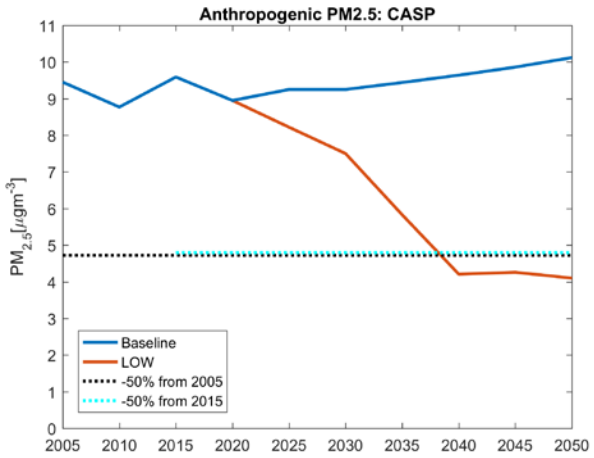


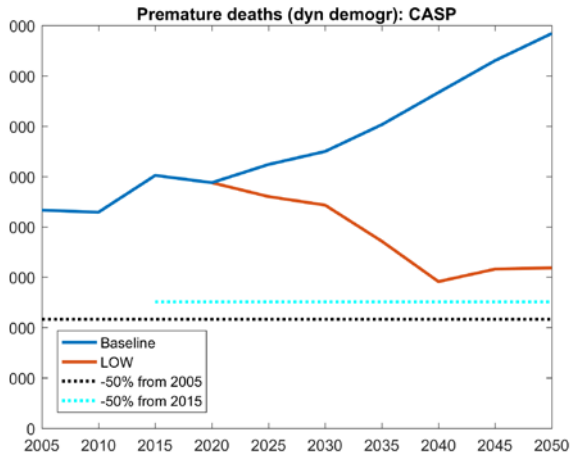
Russian Federation





EECCA (excl Belarus, Russia, Ukraine)





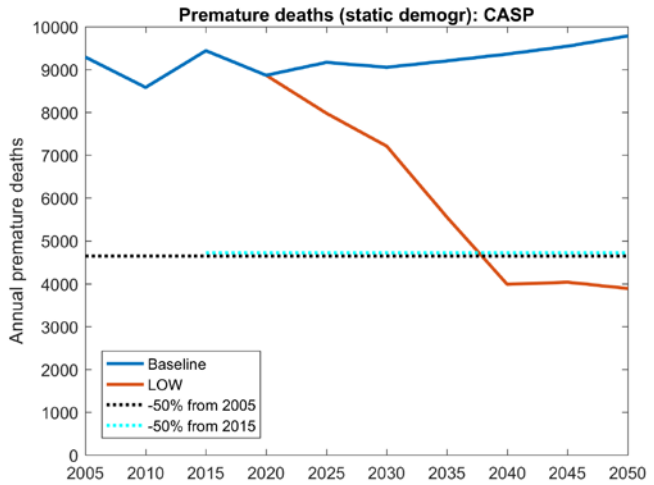
Sensitivity towards methodology

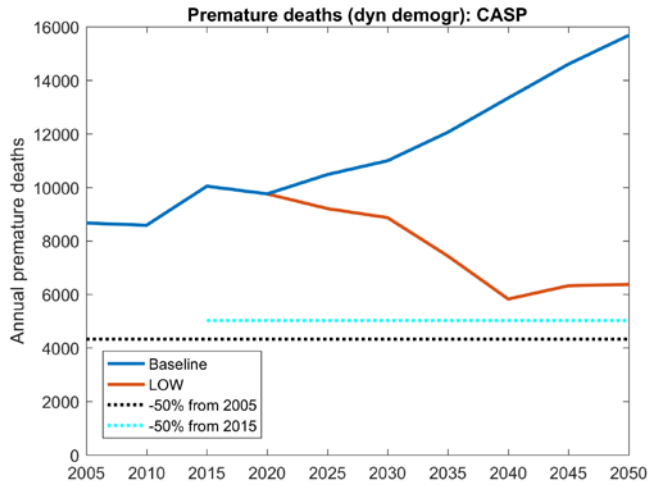
Caspian Region

Constant population

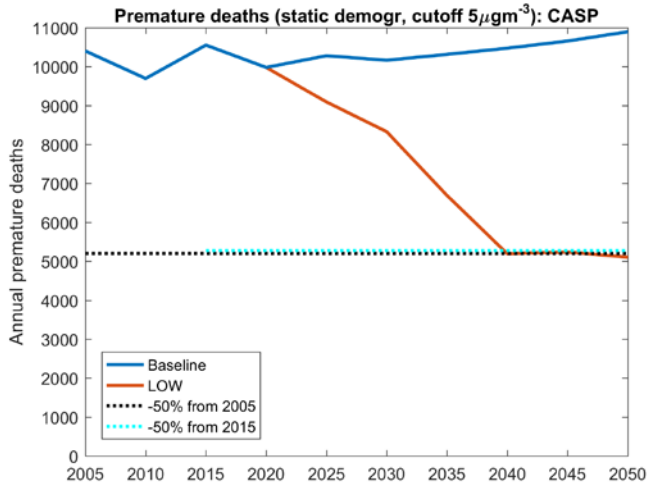
Changing population

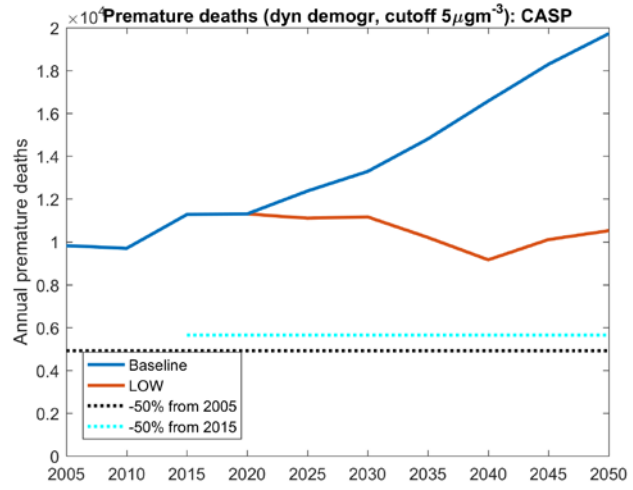
Anthropogenic $PM_{2.5}$





Total $PM_{2.5}$ above 5µgm^{-3}





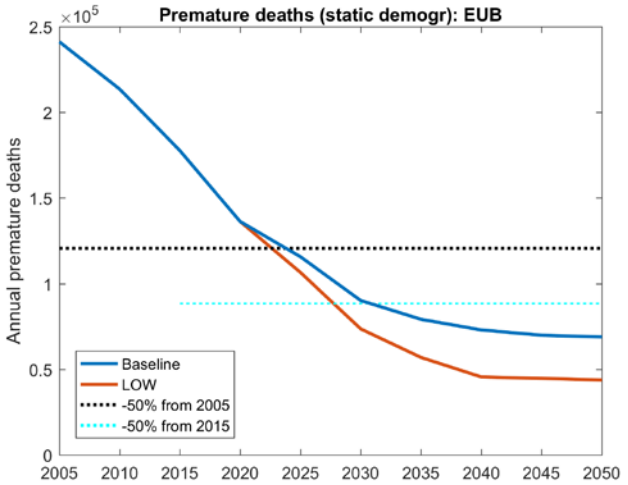
Sensitivity towards methodology

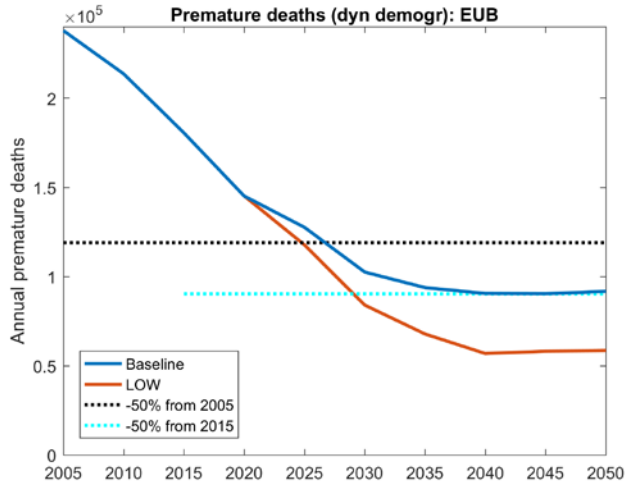
EU mid-income countries

Constant population

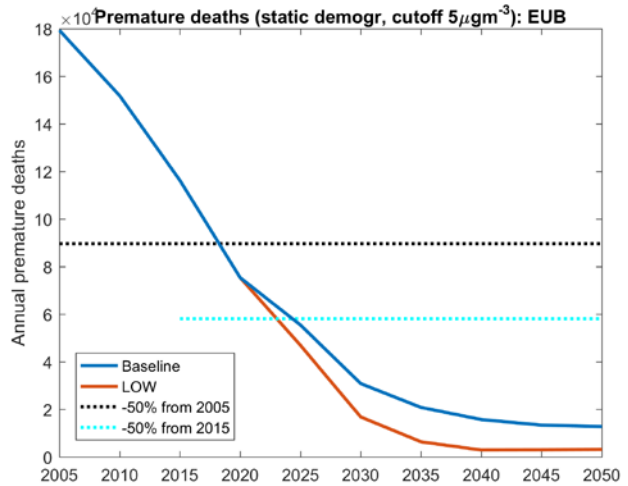
Changing population

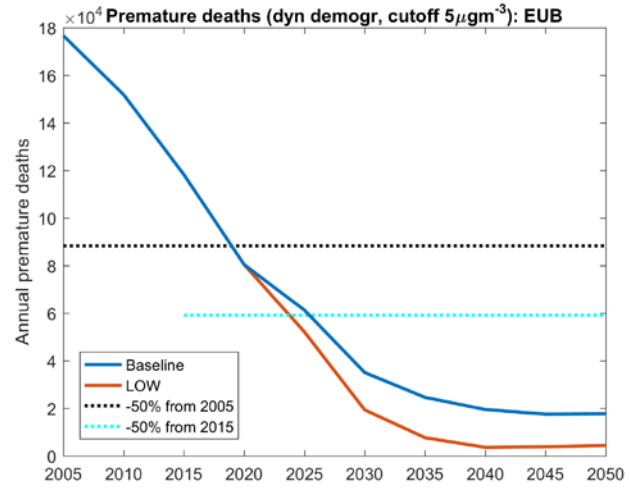
Anthropogenic $PM_{2.5}$





Total $PM_{2.5}$ above 5µgm^{-3}





Summary (1)

Feasibility of a '-50% mortality target'

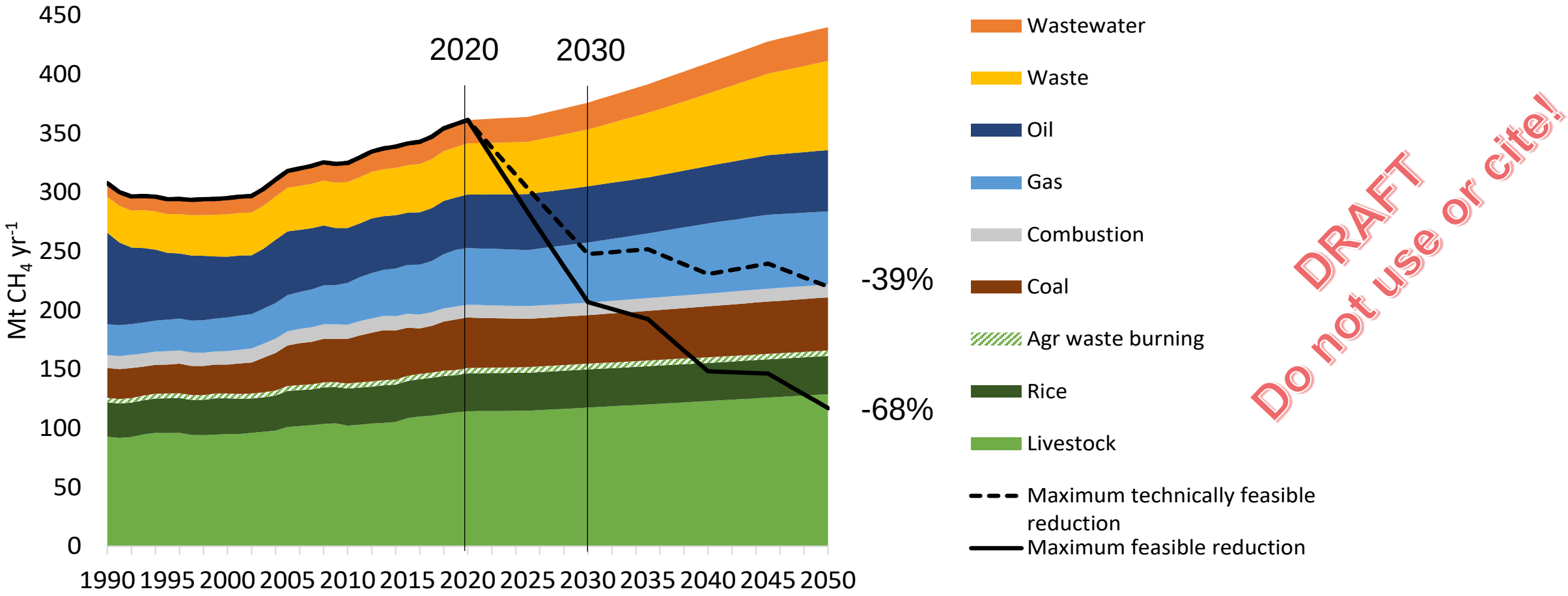
Seems achievable in the UNECE region as a whole and in most but not all countries. Feasibility depends on details of the calculation, i.e., assumptions about CRFs, cutoff, demography, reference year, formulation of potential other targets (e.g., for cities)

- For EU achieved in the Baseline
- Some non-EU countries may struggle to achieve such a target for themselves
- A target (roughly) proportional to anthropogenic $PM_{2.5}$ seems more achievable

New work on methane – *Exploring limits for technical and non-technical mitigation*

Global anthropogenic CH_4 emissions, changes from 2020:

Baseline (IEA-WEO 2021 NPS):	+4% (to 2030)	+22% (to 2050)
Maximum **technically** feasible reduction:	-31% (to 2030)	-39% (to 2050)
Maximum feasible reduction **incl. non-technical**:	-43% (to 2030)	-68% (to 2050)



DRAFT
Do not use or cite!

Source: IIASA-GAINS

Exploring limits of technical and non-technical CH_4 mitigation options –scenario development:

Assumed order of mitigation adoption:

1. **Technical** **"TechLow"**: technical < 20 €/tCO_2eq
   "TechMed": technical 20-100 €/tCO_2eq
   "TechHigh": technical >100 €/tCO_2eq (see Höglund-Isaksson et al., 2020)
2. **"Explore"**: Technologies still in exploration (VAMOX in barns; Improved wood stoves in rich regions)
3. **"Fossil"**: Complete (linear) phase-out of fossil fuels until 2050
4. **"Behave"**: Limit "overconsumption" dairy & beef meat; Food waste -50% in all regions with electricity
5. **"Fair"**: Increase dairy production and consumption in countries with low protein intake
6. **"Develop"**:

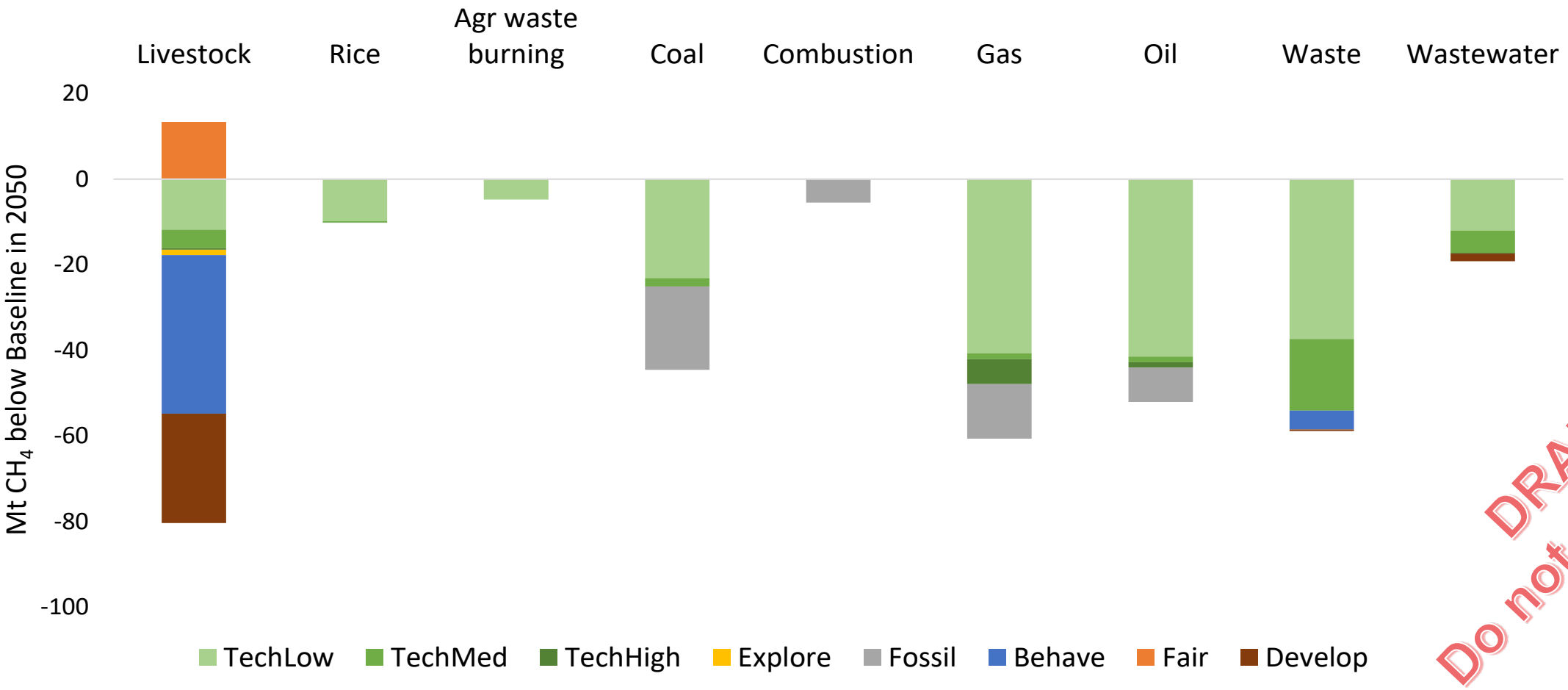
Enhance resilience in pastoralist communities to reduce reliance on livestock herds for risk management;

Improve access to electricity to reduce food waste

Extend wastewater treatment to all urban areas

DRAFT
Do not use or cite!

Global CH_4 mitigation potential below Baseline in 2050 by sector



DRAFT
Do not use or cite!

Source: IIASA-GAINS