Environmental Health Impacts of European Policies for Mitigation of Climate Change – a Case Study for Integrated Health Assessment Using the INTARESE/HEIMTSA Methodology

USTUTT, THL, CERTH, JRC, TNO, IOM, UBath, CUEC, ENPC, RIVM, IC, NILU, ETH-Z, UM-ICIS, INERIS, met.no, MSC-East, UU, UoM, AUTH

The Policy Question:

What are the (negative or positive) impacts of

a) EU mitigation options (policies and resulting measures) to reduce greenhouse gas emissions

b) EU adaptation options (policies and resulting measures) to reduce impacts of climate change

on human health worldwide?

Main activity areas:

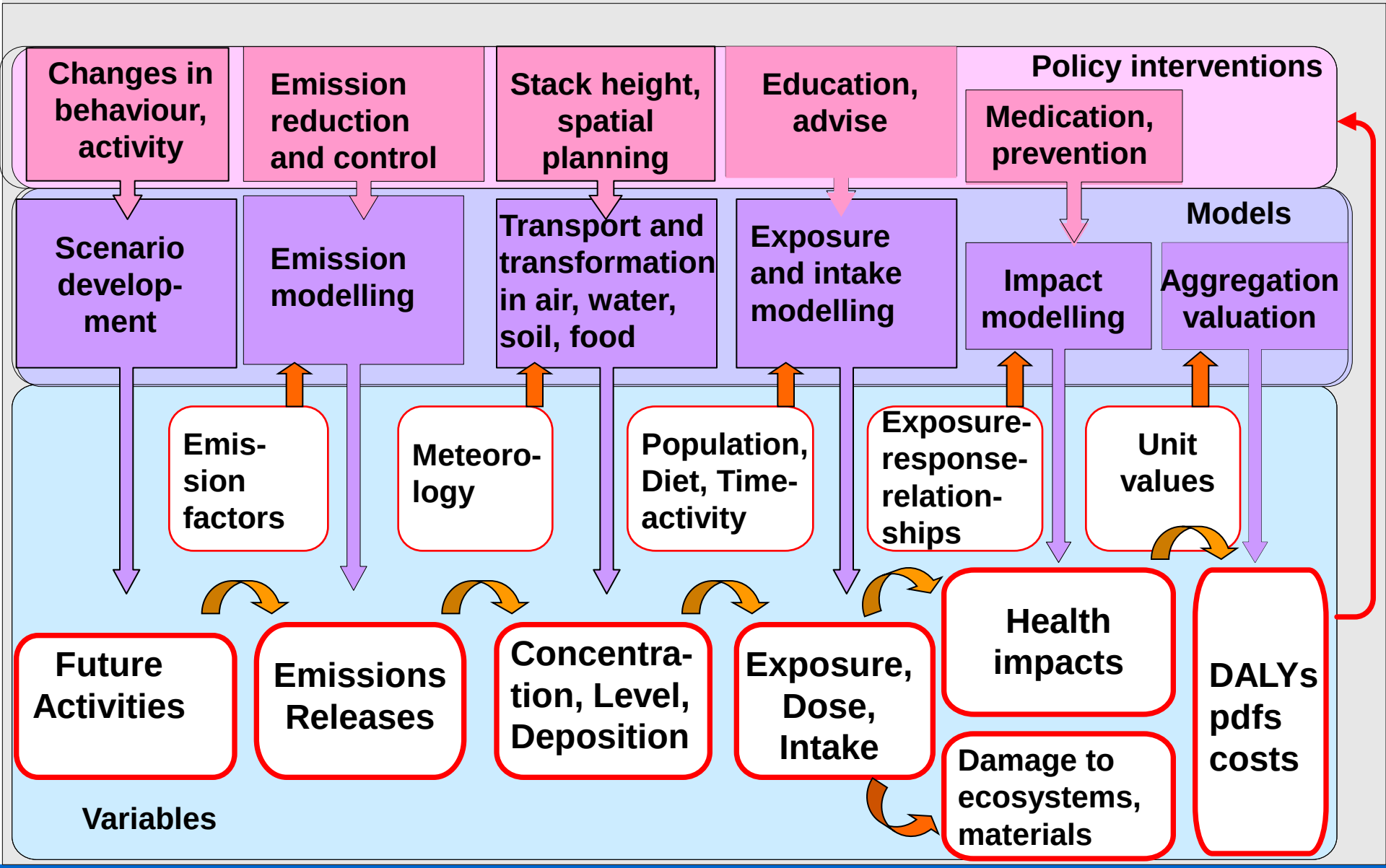
- Energy supply and demand
- Transport
- Agriculture
- Waste
- Buildings and Urban Development

Main Pressures causing env. health impacts:

PM_{10}, $PM_{2.5}$, incl. secondary PM_x, ozone, noise, pesticides, PCBs, dioxins/furanes, heat;

indoor: $PM_{2.5}$, PM_{10}, ETS, radon, mould, formaldehyde

The Full Chain Approach



Step 1: Scenario development

'Business as usual' or reference scenario:

Activities and emission factors follow trend and include agreed policies, however no climate change mitigation measures after 2012;

Some adaptation measures included;

Worldwide GHG emissions and climate change according to IPCC A1B scenario

Step 1: Scenario development

450 ppm or 2° scenario (climate protection scenario):

Embedded in a worldwide emission scenario aiming at not exceeding 2° temperature increase:

Reduction of EU GHG emissions by 20% 1990-2020 and 71% 1990-2050

Climate according to IPCC B1

Constraints:

Share of renewable energy on final energy consumption > 20% 2020, > 40% 2050

At least 10% biofuels in transport fuels 2020

Minimum market shares for electric and hybrid cars

Continuation of national policies of subsidizing renewable energies (e.g. PV)

Emission trading system continues: -31.5 % 2005-2020, then -1.74 % p.a.

General assumptions

	2005	2030	2050
GDP [10^{12} $€_{2007}$]	11,7	17,8	24,4
GDP	Average annual growth 2010 - 2050: 1.7%, Regional differences among countries		
Oil price [$US\$_{2007}$/bbl]	78	100	109
Other assumptions	- additional nuclear power in countries according to current national policy		

Scenario generation:

- **Energy supply:**

  Minimizing energy service supply costs while observing constraints (e.g. maximum CO2 emissions): use of TIMES

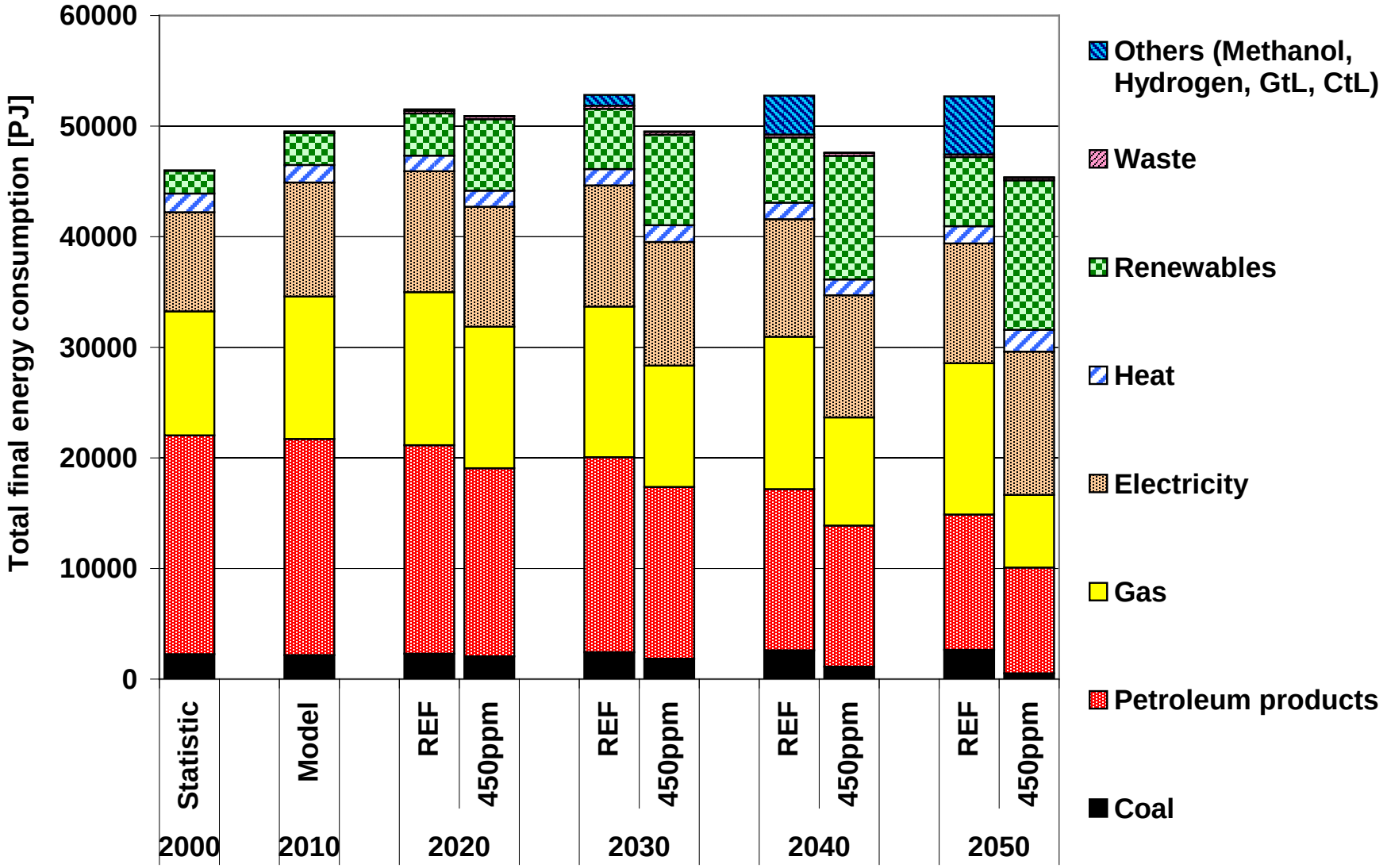
- **Transport:**

  Simulation using a stock-activity-emission factor data base, partly data from TREMOVE

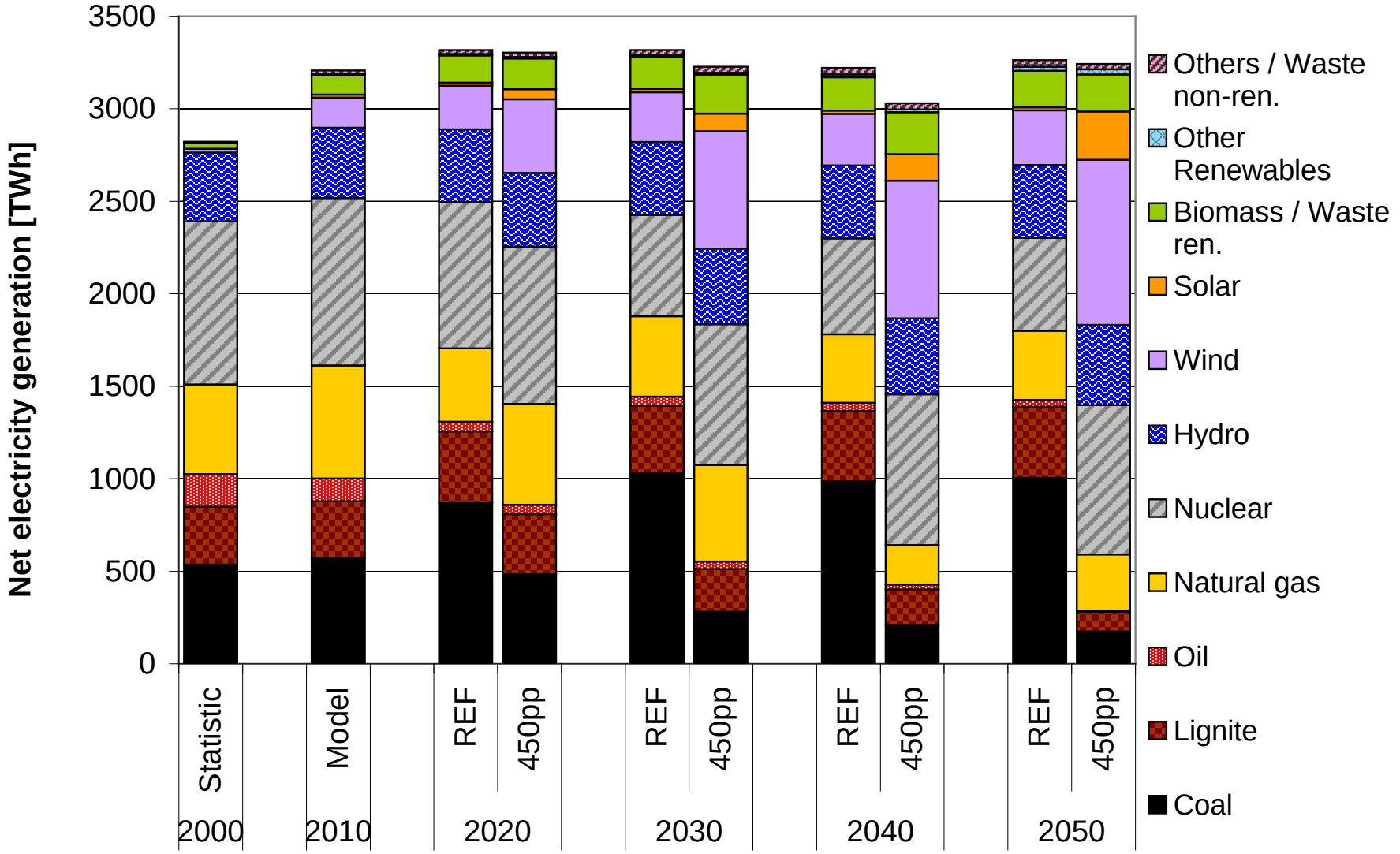
- **Agriculture:**

  use of scenarios from the IMAGE model for food production,

Final energy consumption by fuel (EU27)

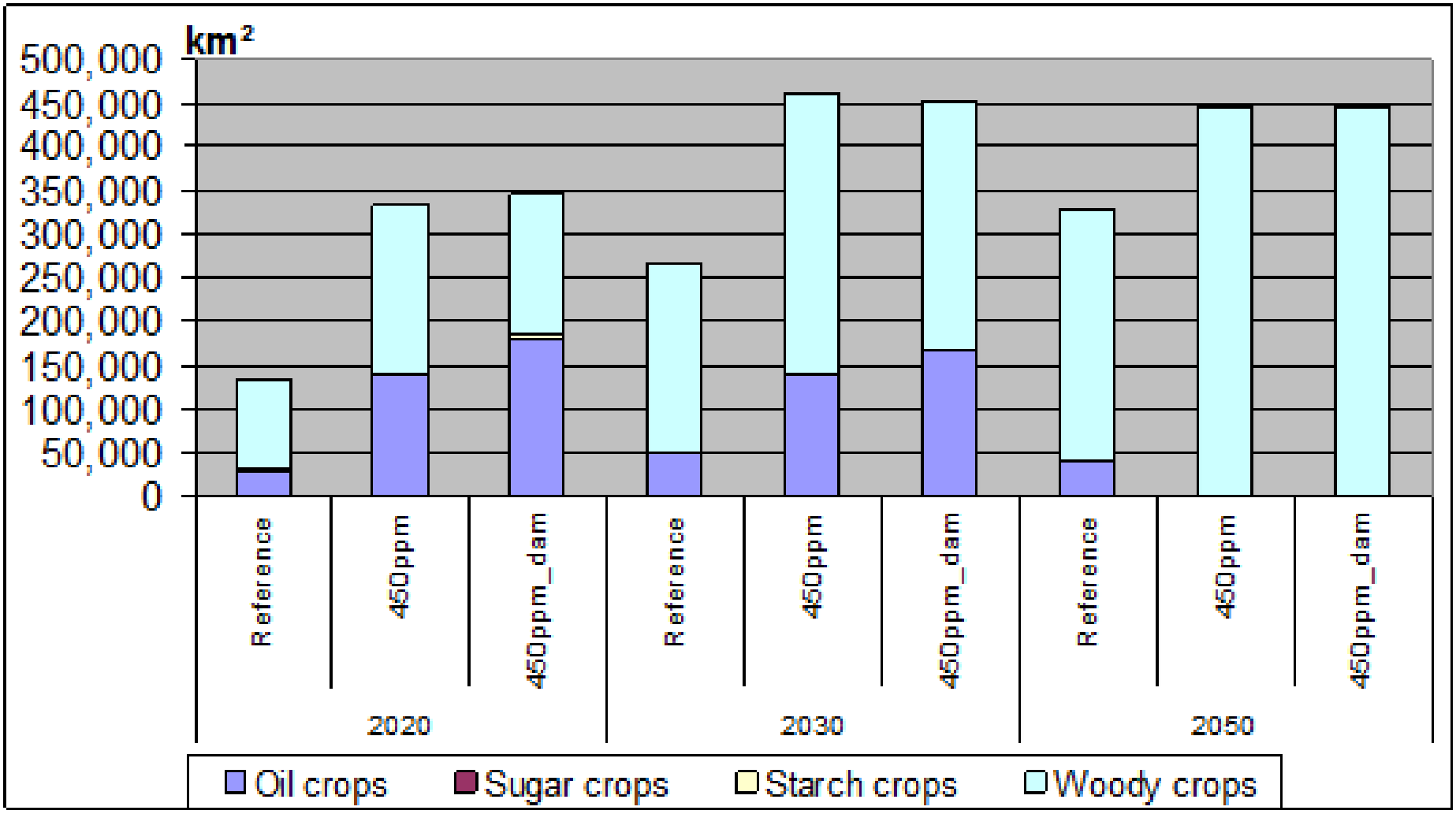


Net Electricity Generation (EU27)

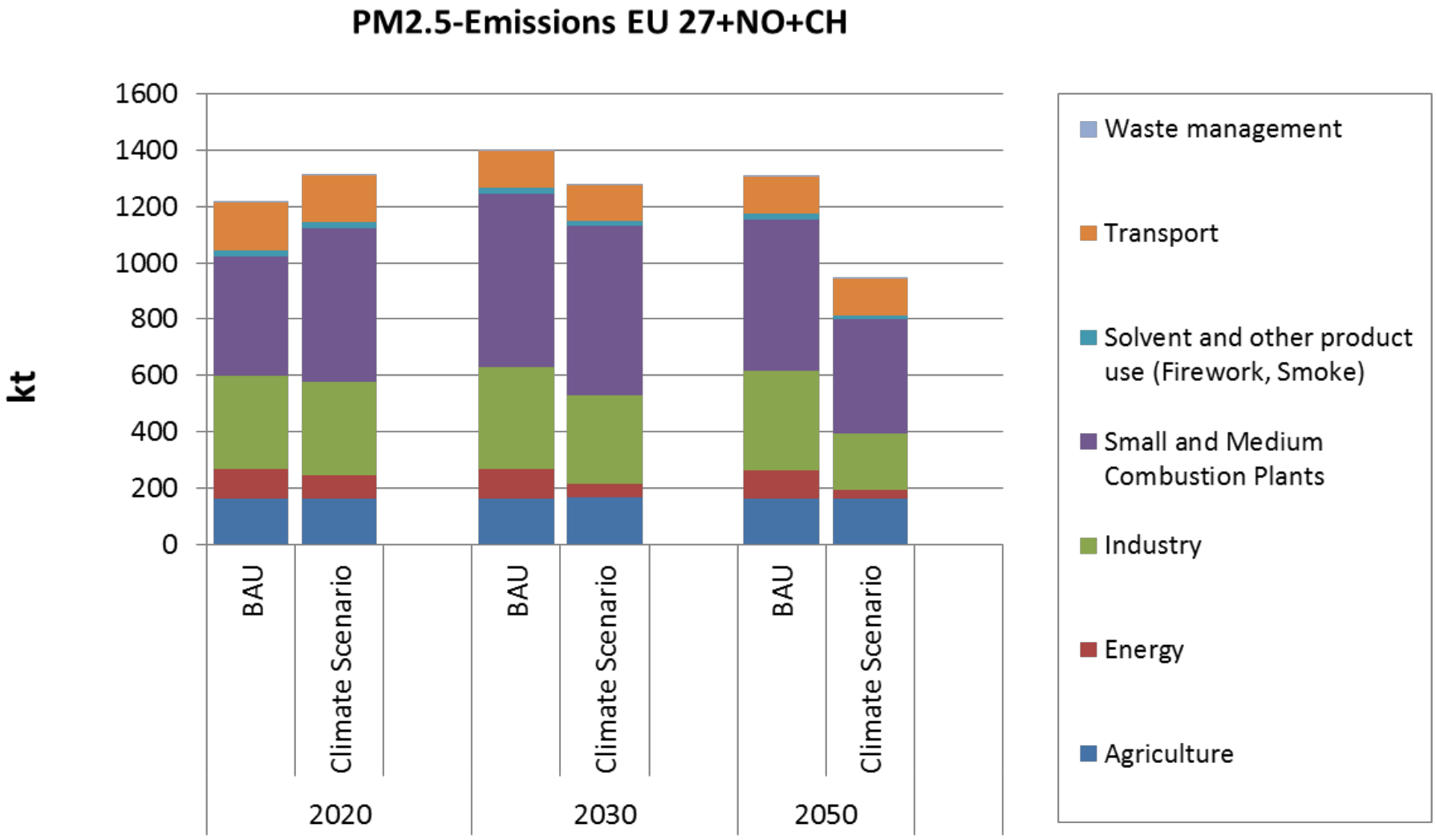


Total land requirement for energy crop production EU

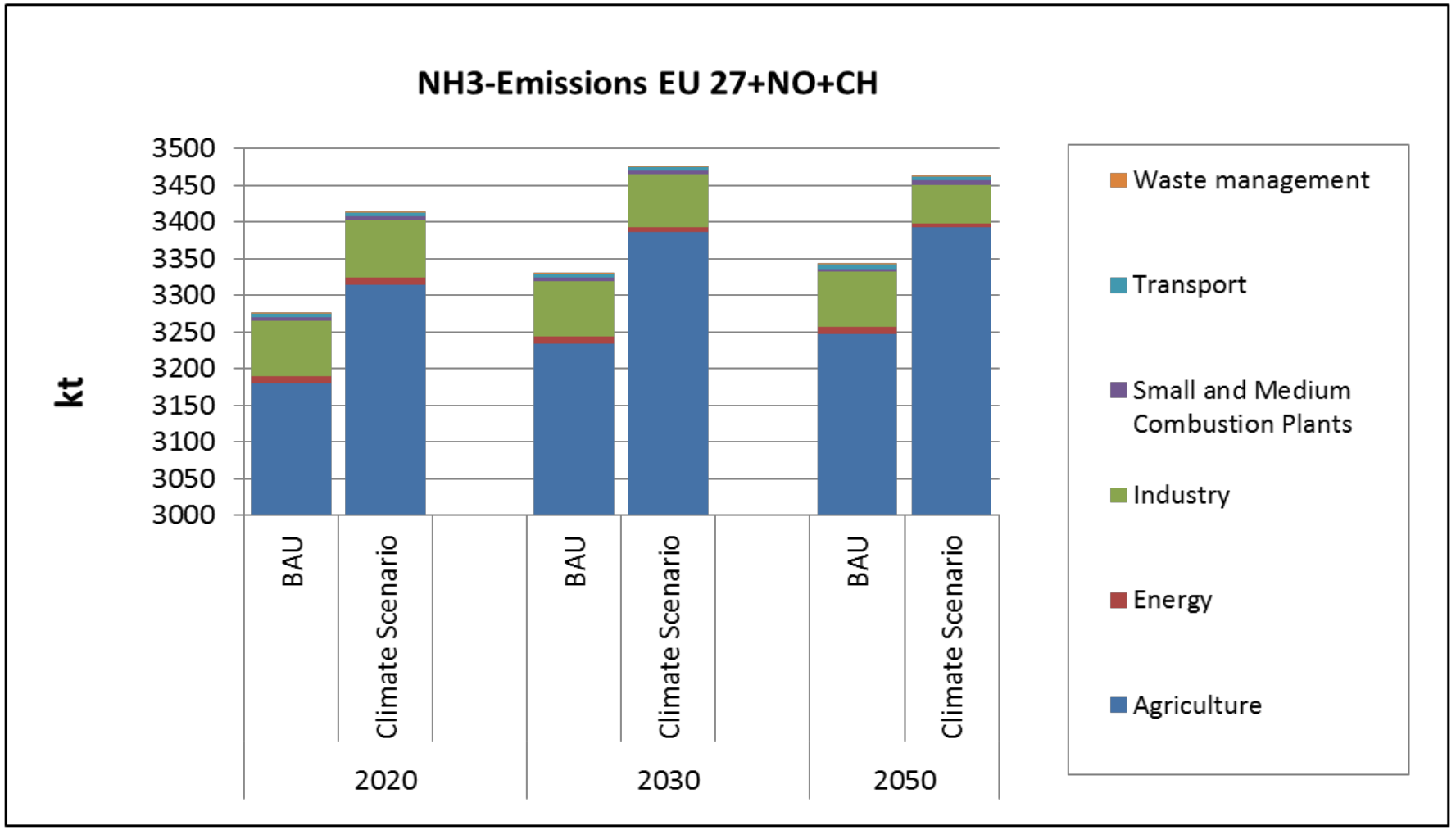
for comparison: arable land for food 1 Mio km² + grassland 0,5 km²



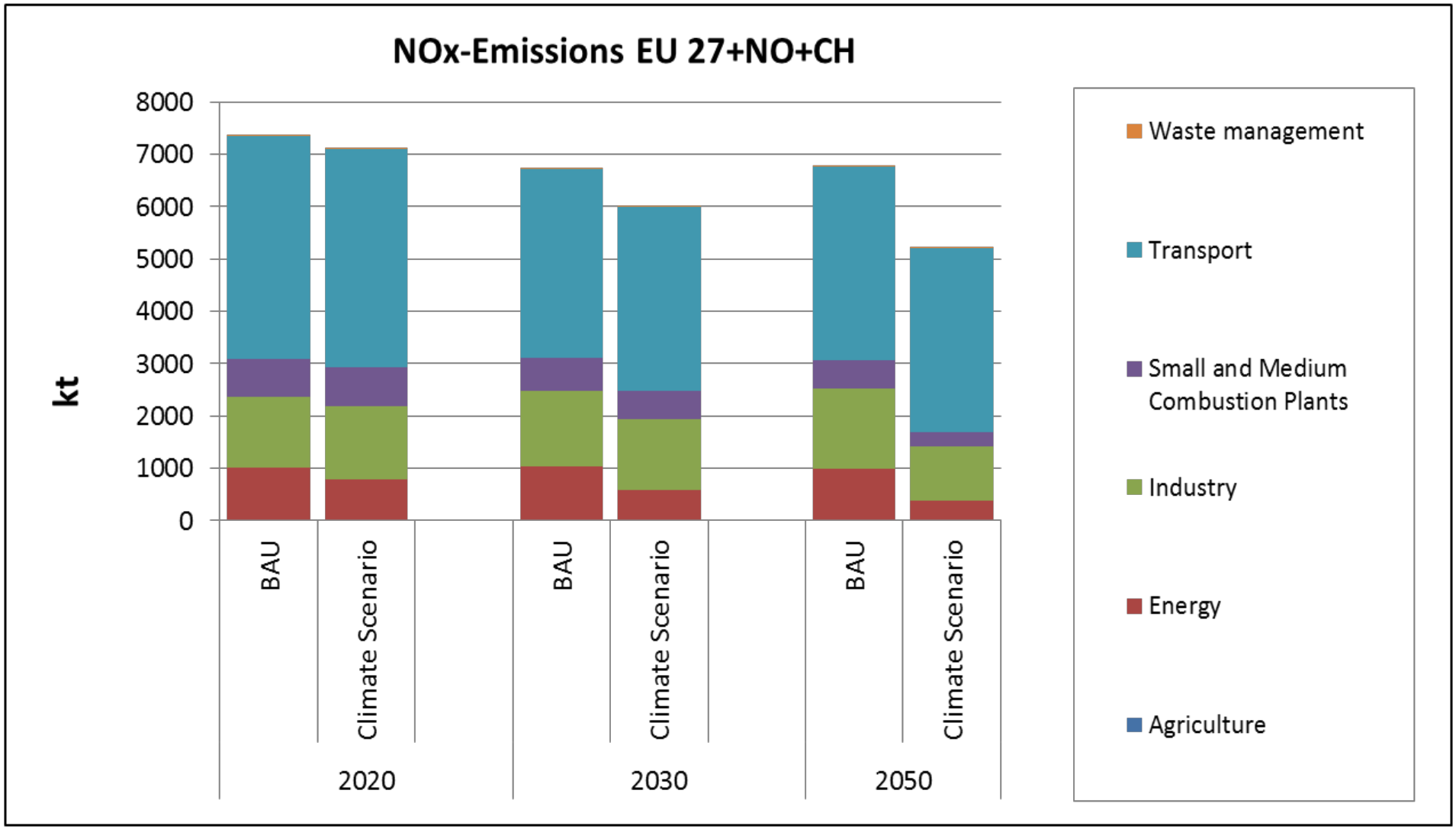
PM2.5-Emissions by Source Category for EU 29



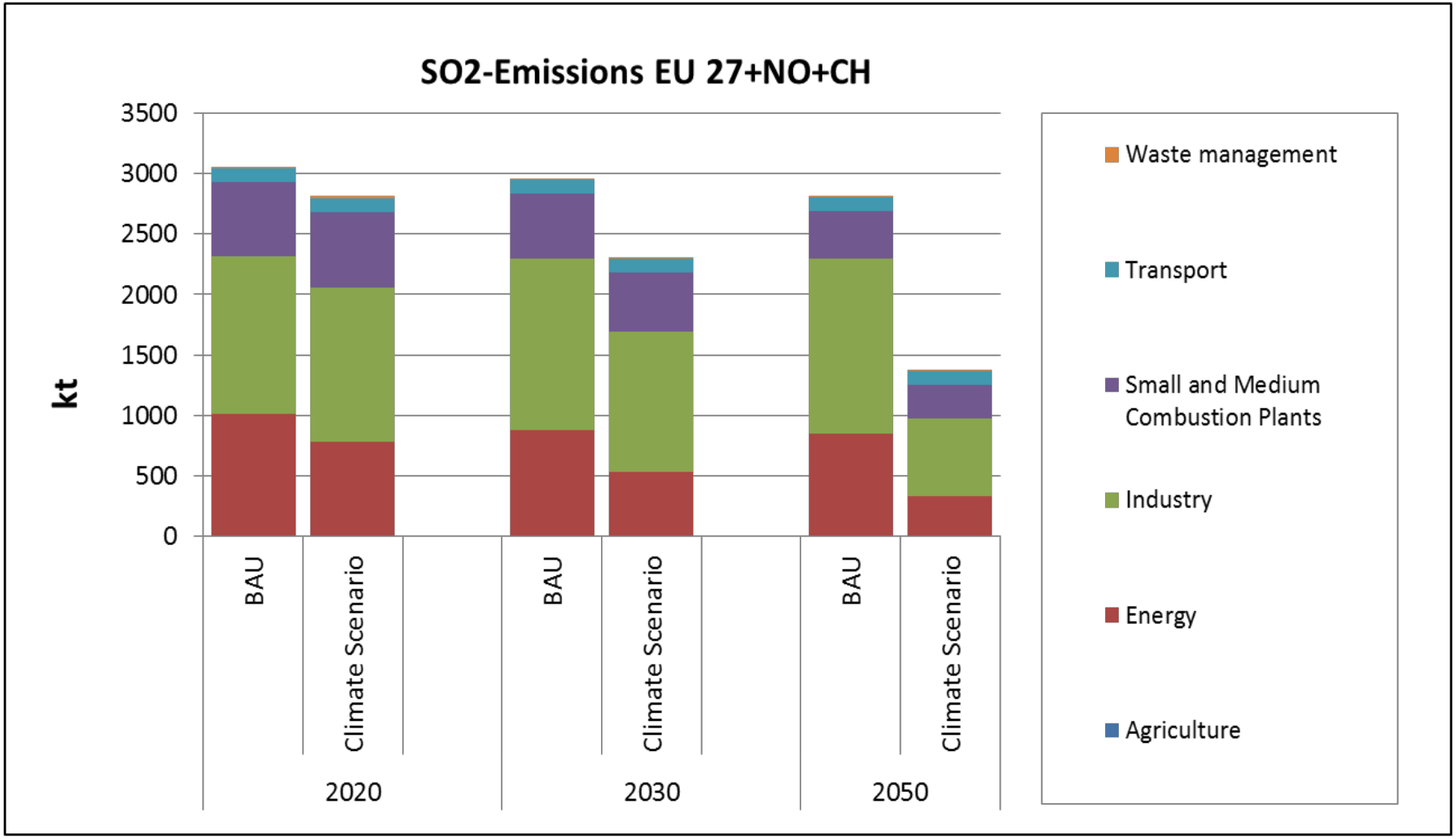
NH_3-Emissions by Source Category for EU 29



NO_x-Emissions by Source Category for EU 29



SO_2-Emissions by Source Category for EU 29



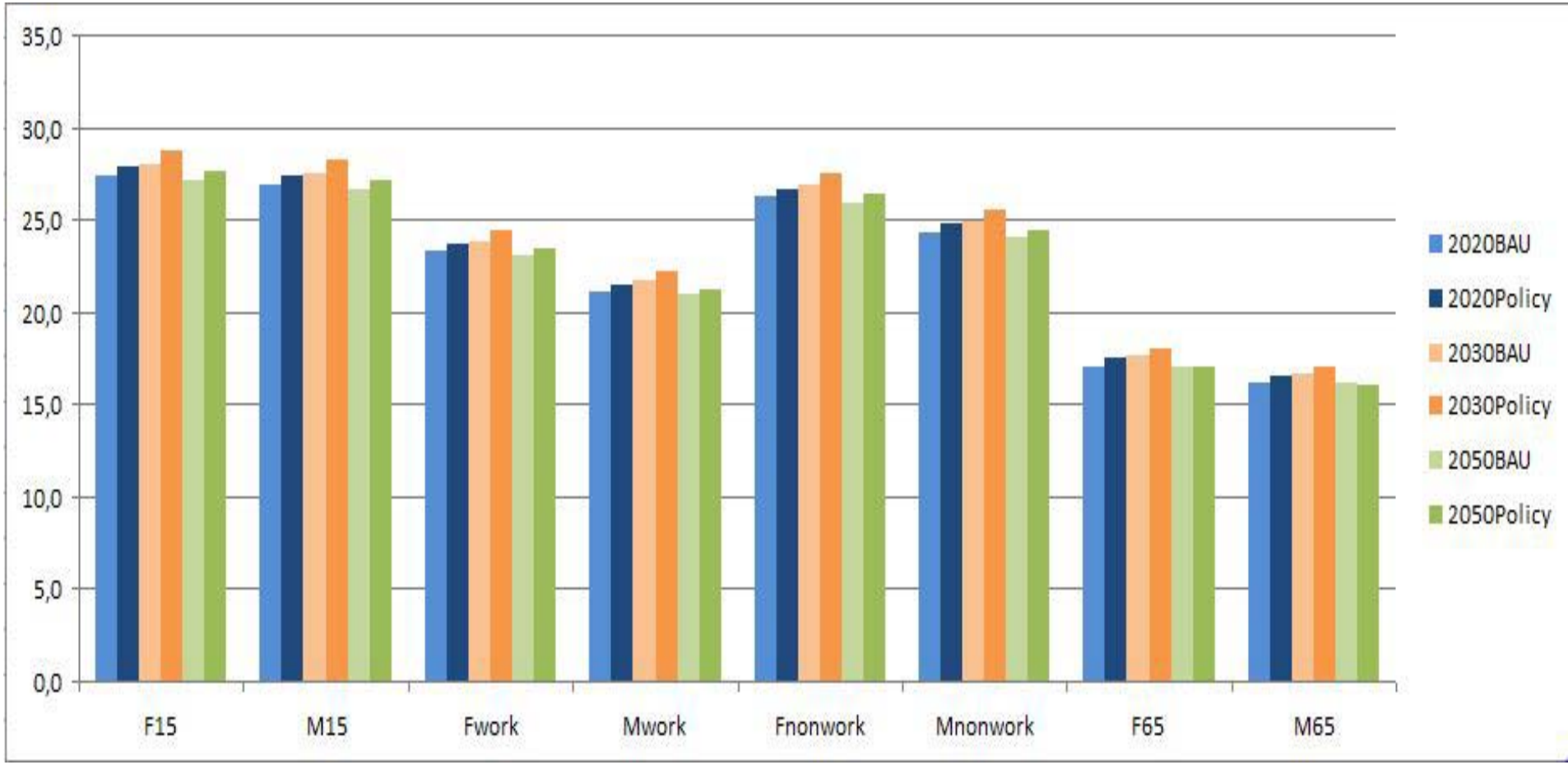
From emissions to concentrations/levels/intake/exposures

Used models:

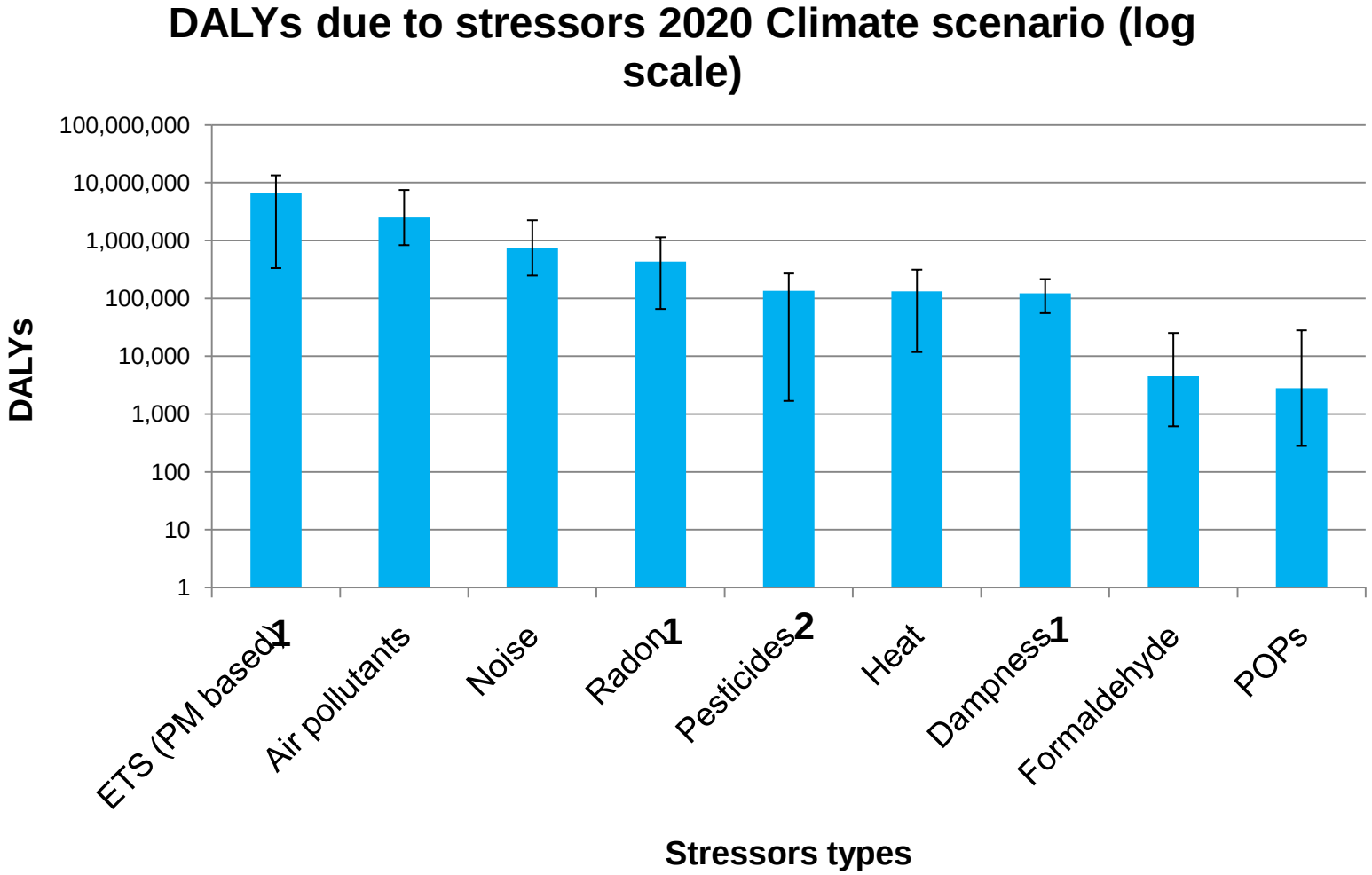
- Outdoor air: EMEP, Polyphemus, Chimere, ECOSENSE (parametrized), MSC-EAST (POPs, pesticides)
- New tool for assessing local impacts of pesticide application
- Urban increment: new ‘urban increment estimation tool‘
- Multimedia to food: new multimedia models dynamiCROP (pesticides), PANGEA (POP)
- Noise: new noise upscaling model
- Indoor: Steady state mass balance model with homogenous mixing
- Exposure: new LAMA model

Personal exposure – Results (in µg/m³)

Average PM2.5 exposure over EU-30 per subgroup for the six scenarios

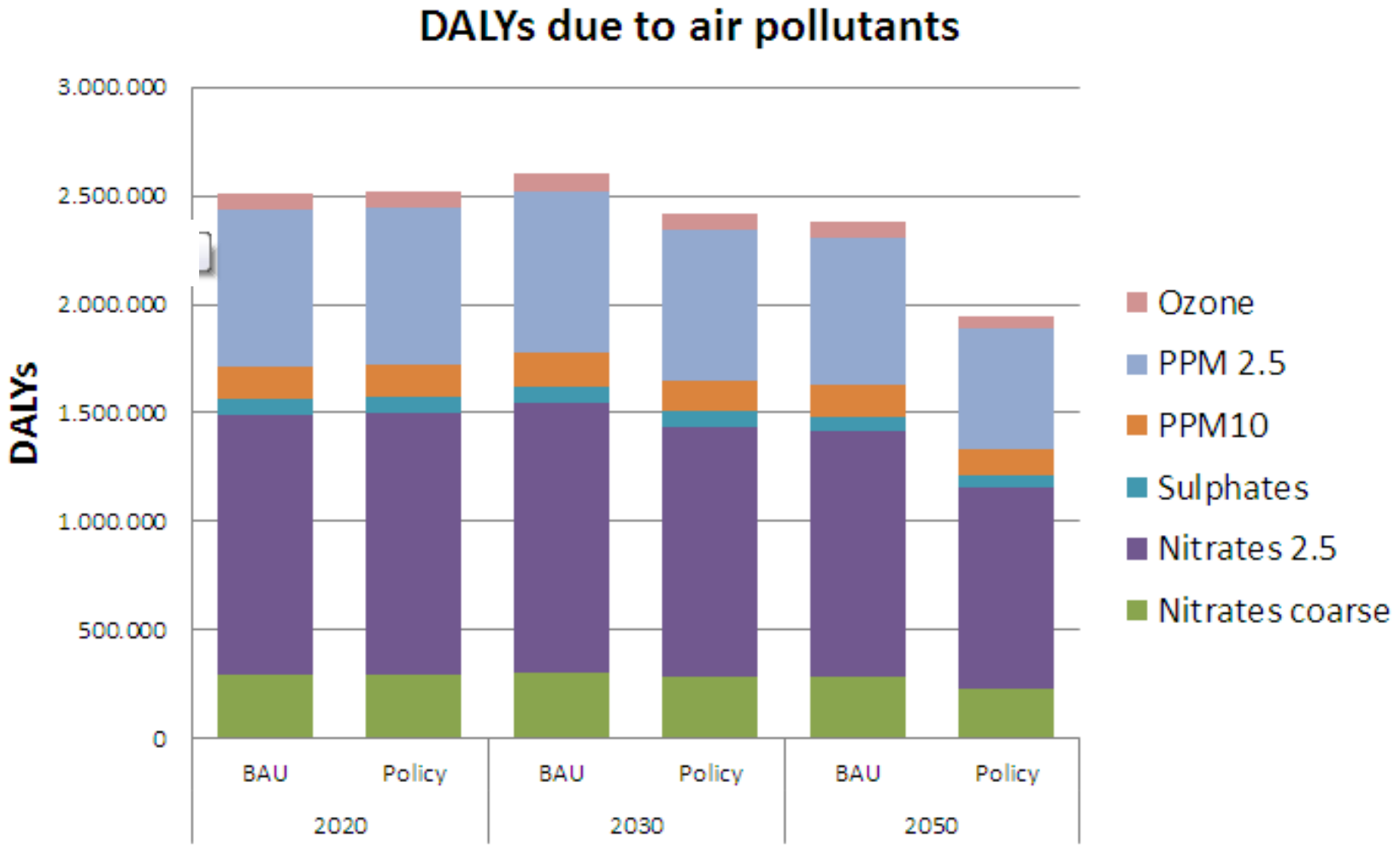


DALYs due to all stressors for 2020 Climate



1 If no additional measures to improve air exchange rate in buildings are implemented.
2 Results from the Exiopol project.

DALYs due to outdoor air pollutants



Air pollutants – sensitivity analysis

	Variant 1	Variant 2	Variant 3
PPM2.5	1	* 1.5	* 1.75
nitrates	1	* 0.5	* 0.25
sulphates	1	* 0.6	* 0.25
PPMcoarse	1	* 1	* 1
nitratescoarse	1	* 0.5	* 0.25

Weighing scheme for different fractions of particulate matter.

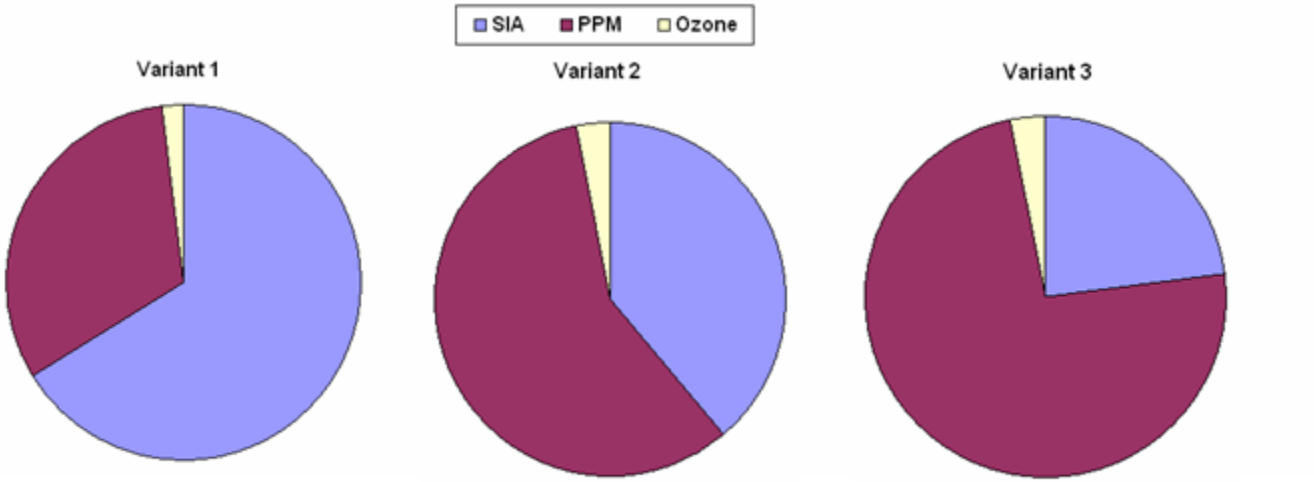
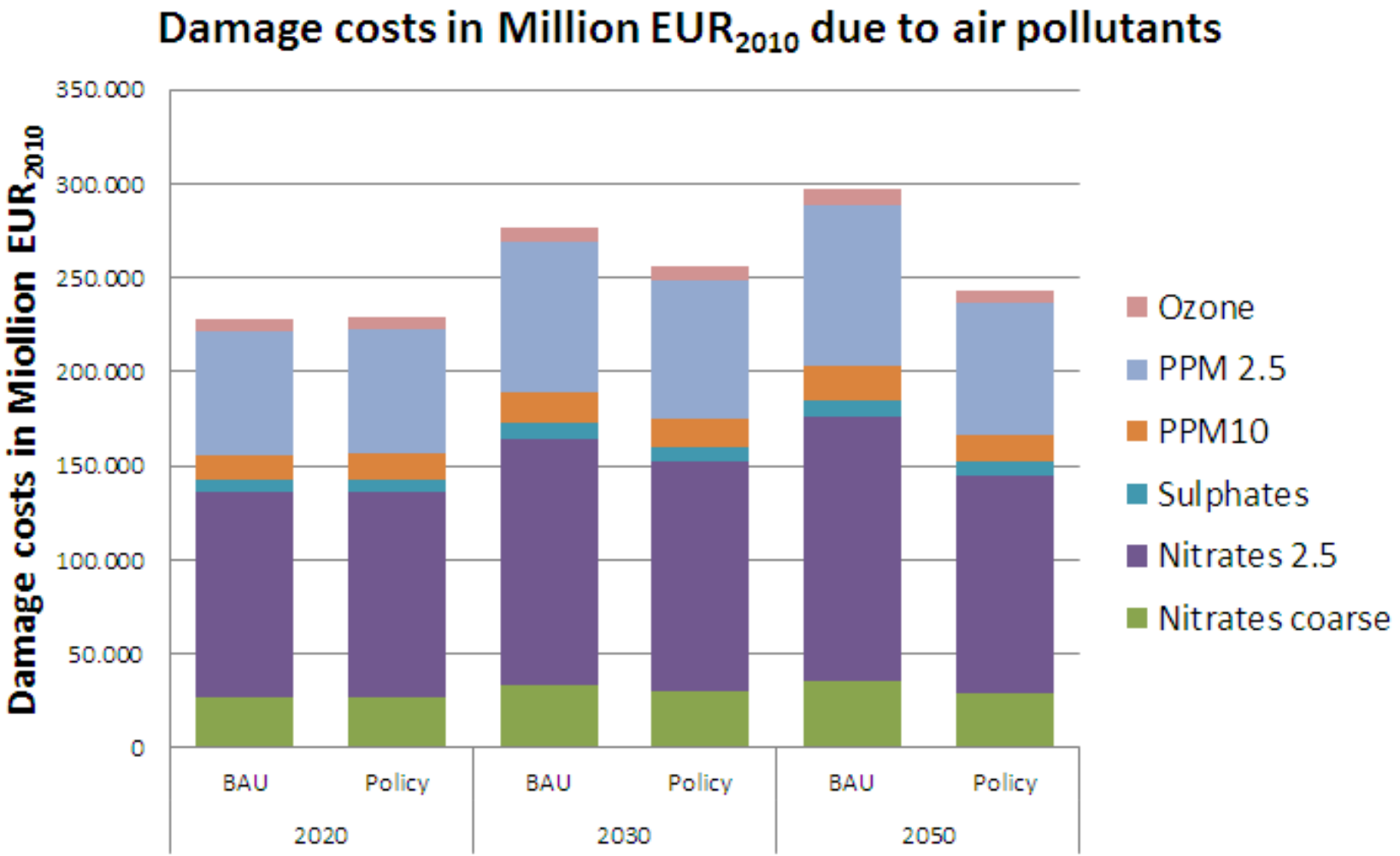
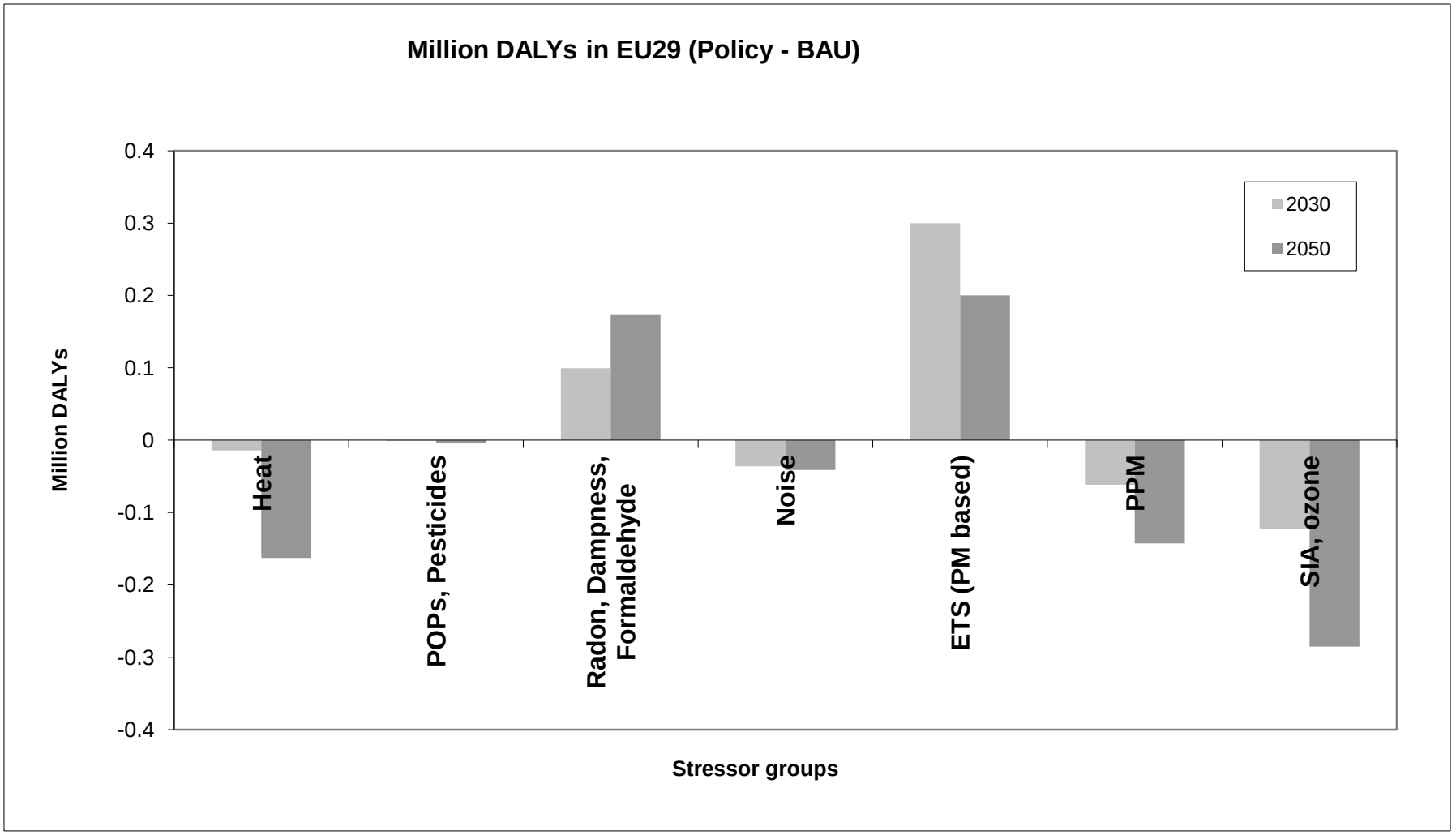


Figure 8-1: DALYs due to outdoor air pollution: Approximate fractions of SIA, PPM and ozone according to different weighing schemes for sensitivity analysis.

Damage costs due to outdoor air pollutants



Differences: Policy – BAU (DALYs)



Insulation Scenario

Change (between insulation and BAU/Ref) in different metrics due to renovation (= *additional* DALYs and damage costs)
(effects due to ETS might be overestimated)

Stressor	DALYs	Damage costs (mio. EUR_{2010})	Emissions of CO_2-equ (tons)	DALYs / kt CO_2-equ.	Damage costs EUR / t CO_2-equ.
PM from ETS	≈ 200,000 to 300,000	≈ 24,000 to 50,000			
Radon	≈ 140,000 to 250,000	≈ 6,310 to 11,270			
Dampness	≈ 35,000 to 60,000	≈ 1,580 to 2,700			
Sum	≈ 560,000	≈ 47,000	-70,000,000	≈ 8	≈ 670

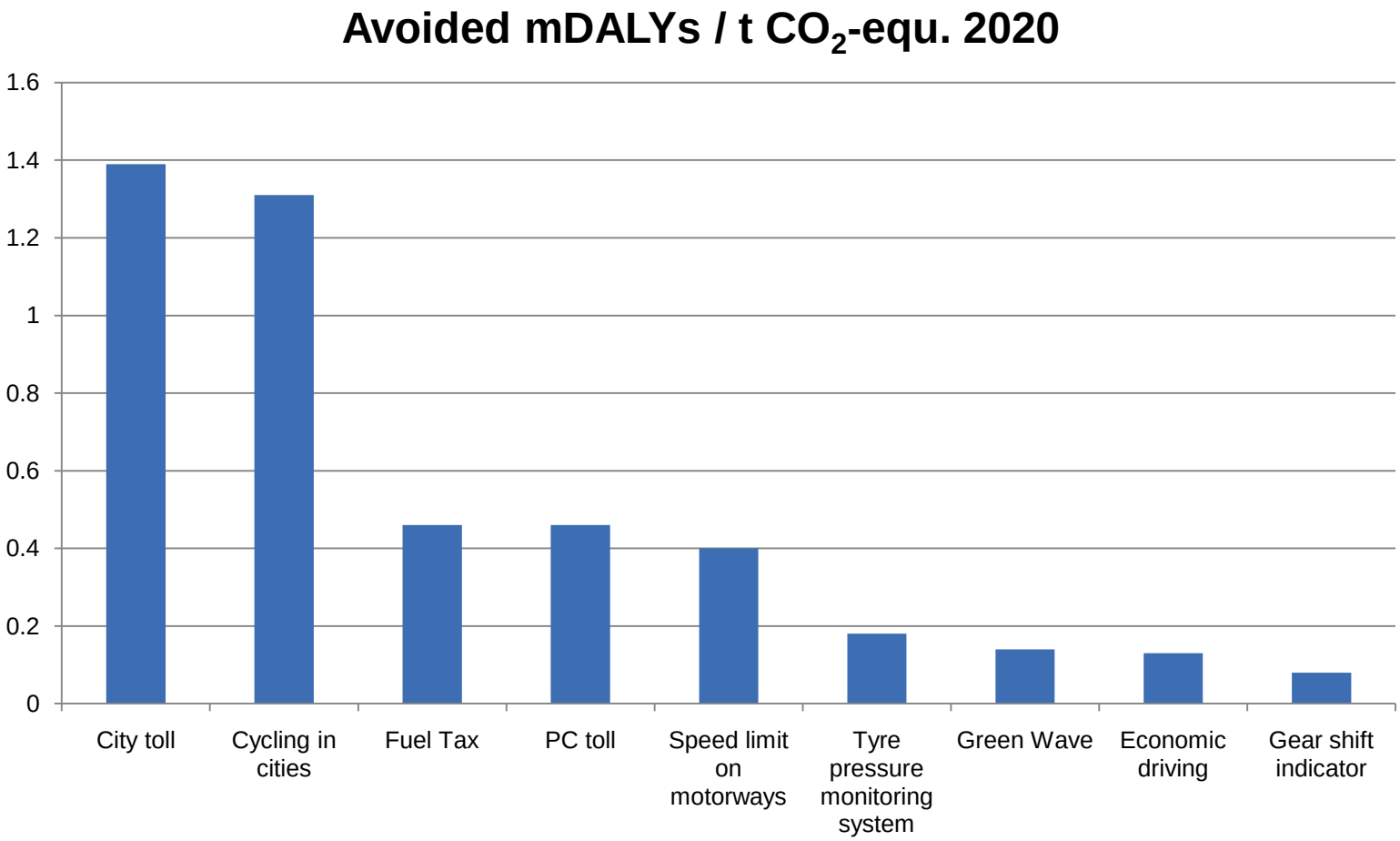
Agriculture 2030

Reduced cattle scenario:

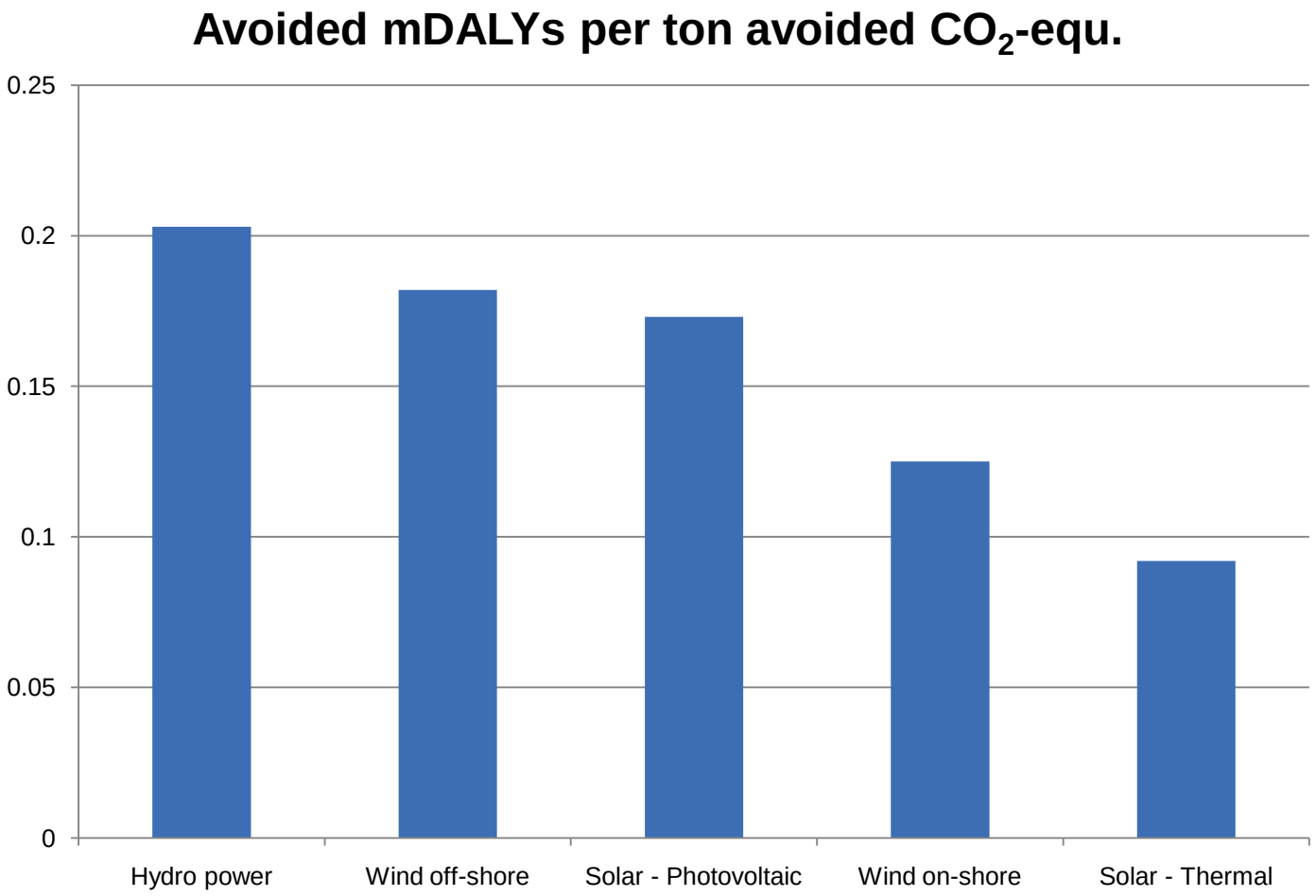
(*additional* DALYs and damage costs)

Policy vs. BAU	2030
Avoided CO_2-equ. [kt]	13,000
Additional damage costs [million EUR_{2010}]	6,000
Add. EUR / t avoided CO_2-equ.	460
Add. mDALY / t avoided CO_2-equ.	8

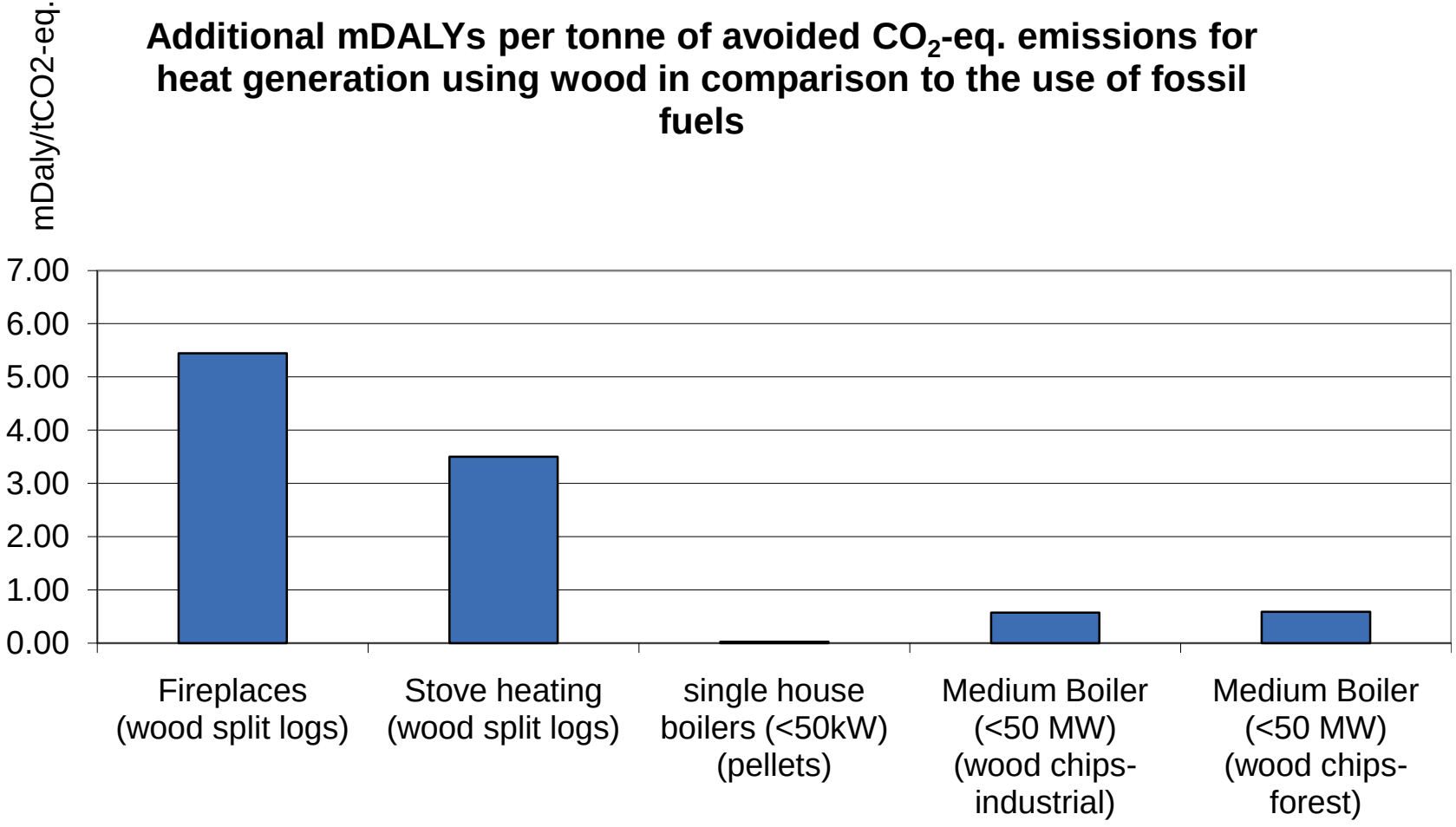
Single measures traffic 2020



Single measures 2020 electricity generation



Additional mDALYs per tonne of avoided CO_2-eq. emissions for heat generation using wood in comparison to the use of fossil fuels



Conclusions

i. **The impact of most climate change mitigation policies on environmental human health is about as important as the climate change effects.**

ii. **Some policies, especially biomass burning and reducing air exchange rates in houses, cause quite high additional health impacts.**

iii. **The analysis allows a ranking of stressors in environmental media with regard to overall health impacts:**

PM (and PM-based ETS) -> noise, radon -> ozone -> mould -> dioxins, heat waves, pesticides -> PCBs -> formaldehyde

iv. **In general: relevant 'side effects' will change policy recommendations substantially, should thus be taken into account when making decisions and can be taken into account using the IEHIA methodology**

More information: www.integrated-assessment.eu