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Greenhouse Gas and
Air Pollution
INteractions and
Synergies (GAINS)

Integrated Assessment & Measures

ENERO – European Conference

Interactions between Atmospheric Pollution and Climate at Regional Scale

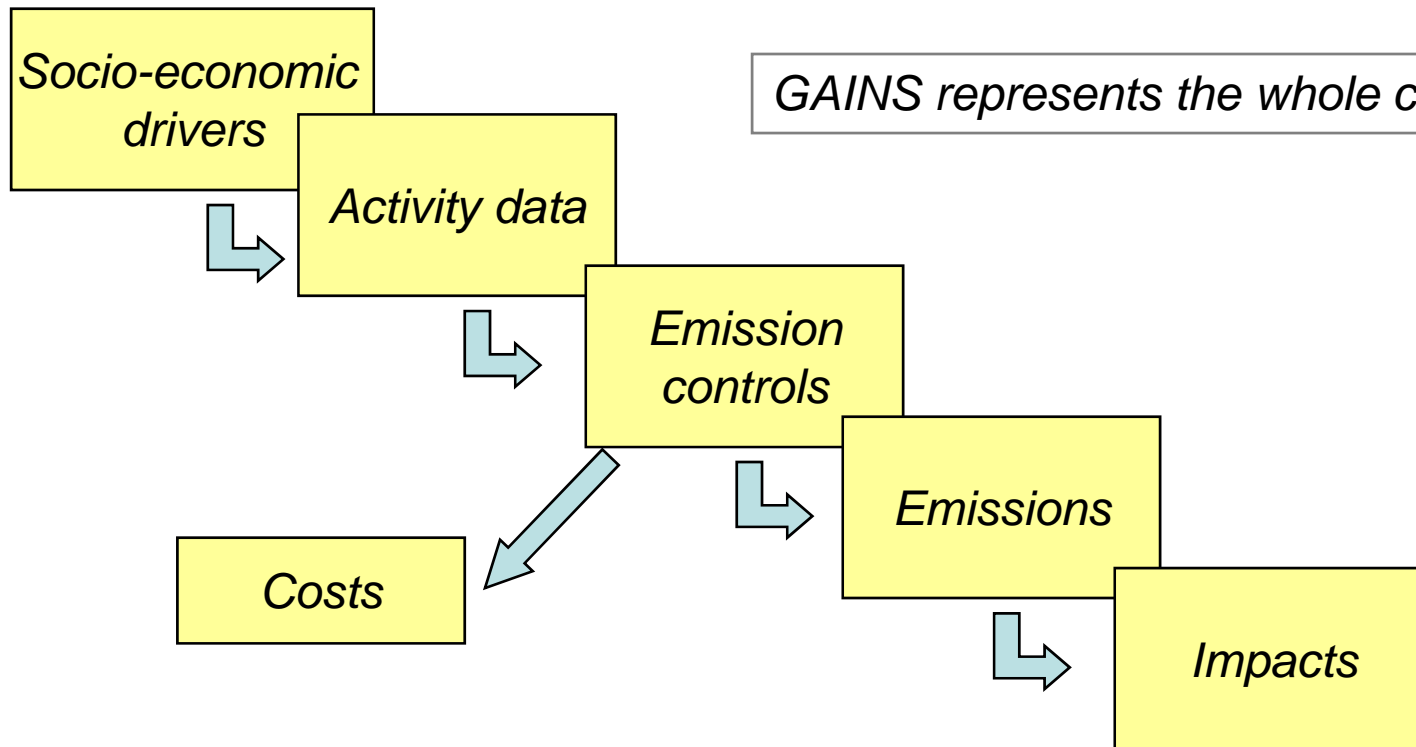
Brussels, 14 February 2008

Outline



1. Overview GAINS Model
2. Measures and their Interactions
3. Some Results
4. Summary

Integrated Assessment: GAINS approach



GAINS represents the whole cause-effect chain

GAINS represents relevant policies

Part I: Overview GAINS model



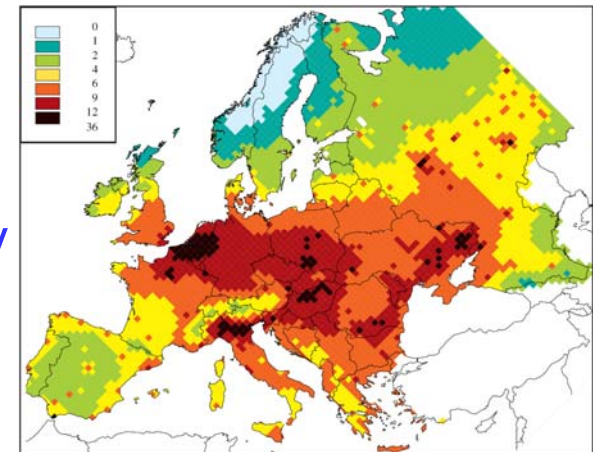
1. Extension of the integrated assessment model RAINS to GHGs
2. Objectives of GAINS:
 - Develop consistent future emission scenarios
 - Find cost-effective control measures
 - Be consistent with national/regional emission inventory
3. GAINS integrates: multi-gas multi-sector, multi-region
4. Versions for Europe, India, China, World
5. Applications of GAINS/RAINS:
 - LRTAP convention
 - EC (e.g. CAFE, National Emission Ceilings Directive)

Part I: Overview GAINS model (2)



Scope:

- 43 regions (+15 sea regions) in Europe
- 10 pollutants + Kyoto gases
- Some 400 socio-economic activities per region
- Some 1,500 add-on control measures
- Energy saving & efficiency improvements, Fuel substitution measures
- Contains information on ecosystems, critical loads, health risk factors, meteorology



The GAINS model: The RAINS multi-pollutant/ multi-effect framework extended to GHGs



Economic synergies between emission control measures

Multiple benefits

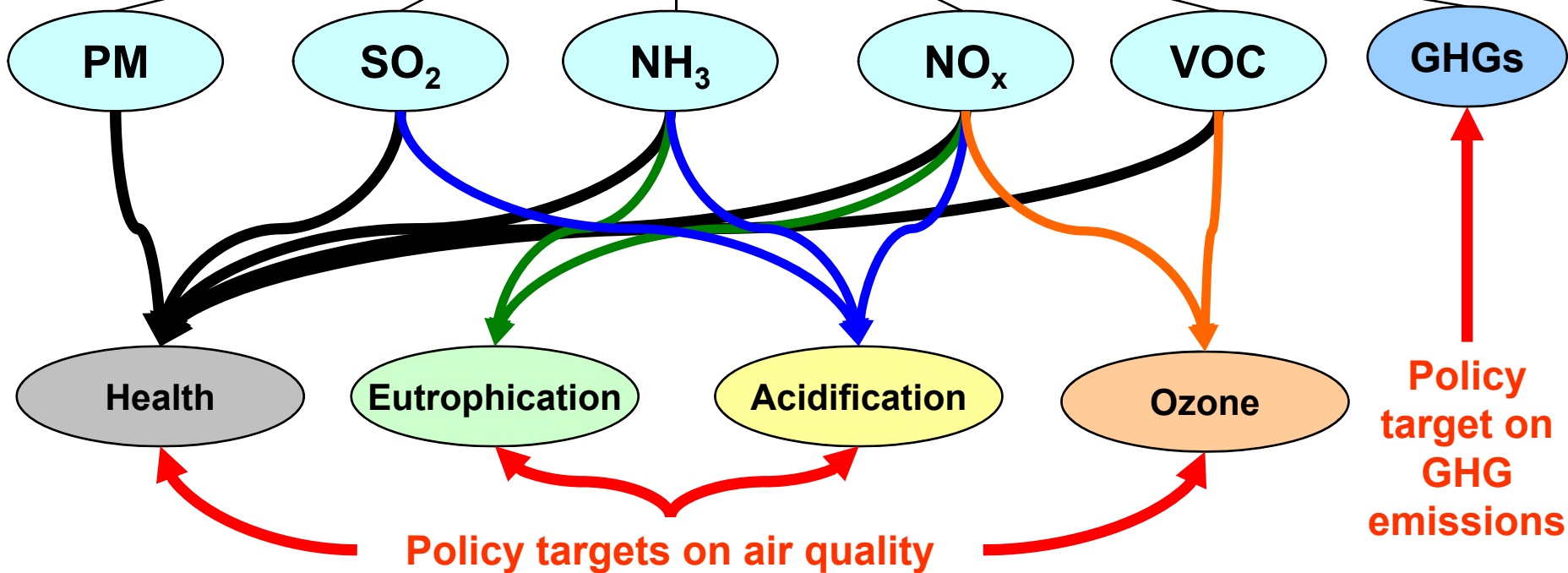
	PM	SO ₂	NO _x	VOC	NH ₃	CO ₂	CH ₄	N ₂ O	CFCs HFCs SF ₆
Health impacts: PM	✓	✓	✓		✓				
O ₃			✓	✓			✓		
Vegetation damage: O ₃			✓	✓			✓		
Acidification		✓							
Eutrophication			✓		✓				
Radiative forcing: - direct						✓	✓	✓	✓
- via aerosols	✓	✓	✓		✓				
- via OH			✓	✓			✓		

Physical interactions

The GAINS model finds cost-effective emission control strategies



IIASA's GAINS
optimization model



Part II



Measures and their interactions

Multi-pollutant measures (1)



- Stationary sources:
 - Integrated Gasification Combined Cycle: CO_2 , SO_2 , NO_x , PM ↓
 - Combined Heat and Power: all pollutants ↓
 - SCR, SNCR: NO_x , CO ↓, NH_3 , N_2O ↑
 - Fluidized bed combustion: SO_2 , NO_x ↓, N_2O ↑
 - New residential boilers: VOC, PM, CO, CH_4 ↓
- Structural measures:
 - Energy savings, efficiency improvements, bans: all pollutants ↓
 - Increased use of natural gas: CO_2 , SO_2 , VOC, NO_x , PM ↓, CH_4 ↑
 - Biomass: CO_2 ↓, VOC, PM, CH_4 ↑

Multi-pollutant measures (2)



- Mobile sources:
 - Euro-standards: NO_x , VOC, PM, CO ↓ NH_3 , N_2O ↑
 - Low sulfur fuels: SO_2 , PM ↓
 - Diesel: CO_2 ↓, PM ↑
- Agricultural sources:
 - Low emission pig housing – NH_3 , CH_4 ↓ N_2O ↑
 - Covered storage of slurry – NH_3 ↓ CH_4 ↑
 - Injection of manure – NH_3 ↓ N_2O ↑
 - Anaerobic digestion (biogas) – CH_4 , CO_2 , N_2O ↓ NH_3 ↓ ↑

Multi-pollutant measures (3)



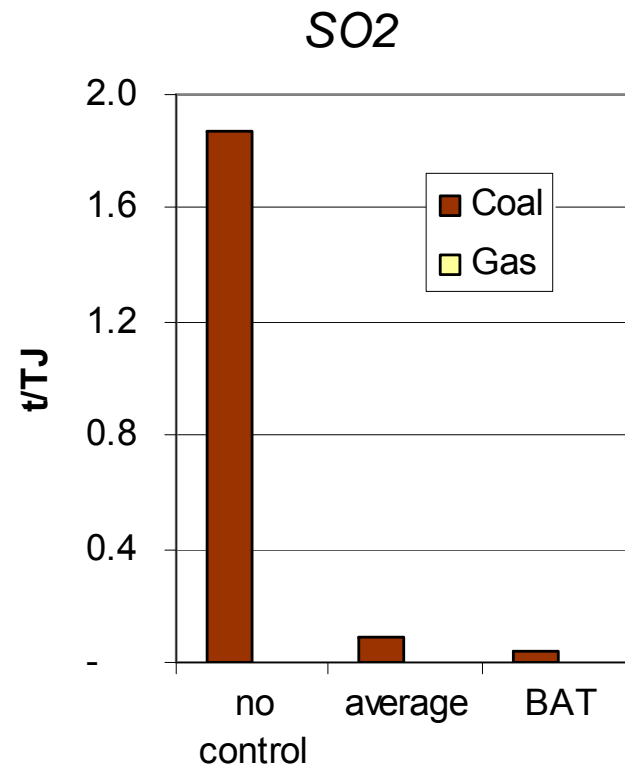
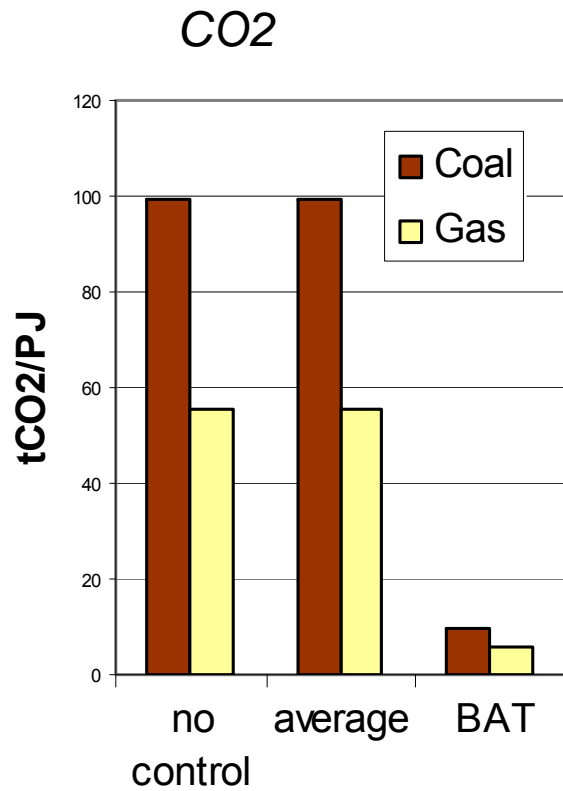
- Other sources
 - Gas recovery and flaring: CH_4 ↓ CO_2 , PM, VOC, SO_2 , NO_x , CO ↑
 - Gas recovery and re-use: CH_4 , CO_2 ↓
 - Improving flaring efficiency: PM, VOC, NO_x , SO_2 , CO ↓
 - Waste incineration: CH_4 , CO_2 ↓ ↑
 - Gas recovery from wastewater treatment: CH_4 , CO_2 ↓

Part III



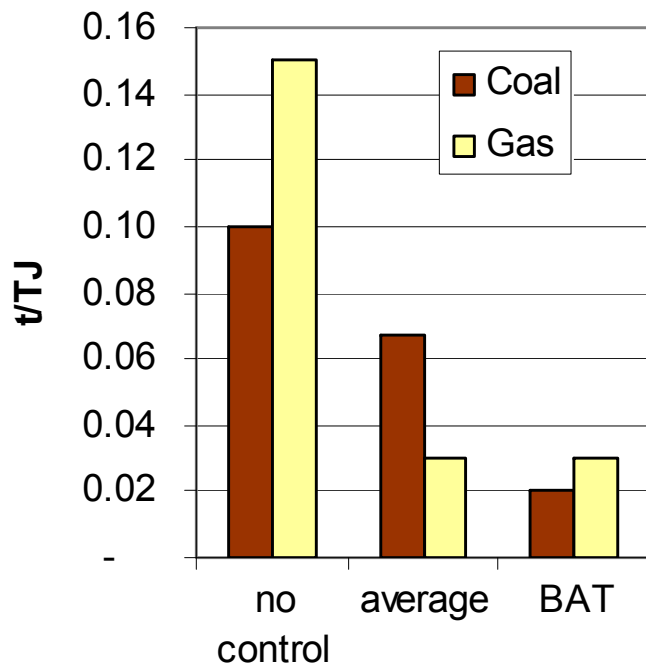
Some Results

Co-benefits: switch from coal to gas power plants

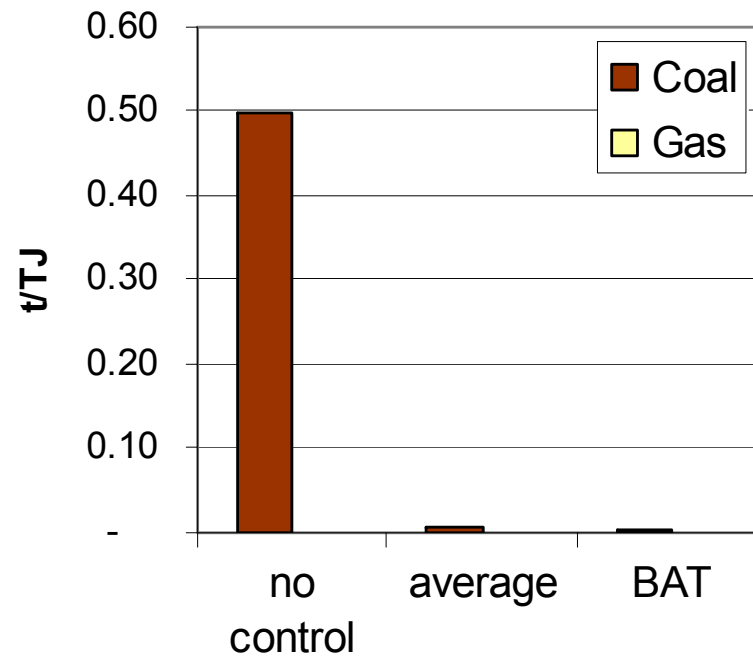


Co-benefits: switch from coal to gas power plants

NO_x

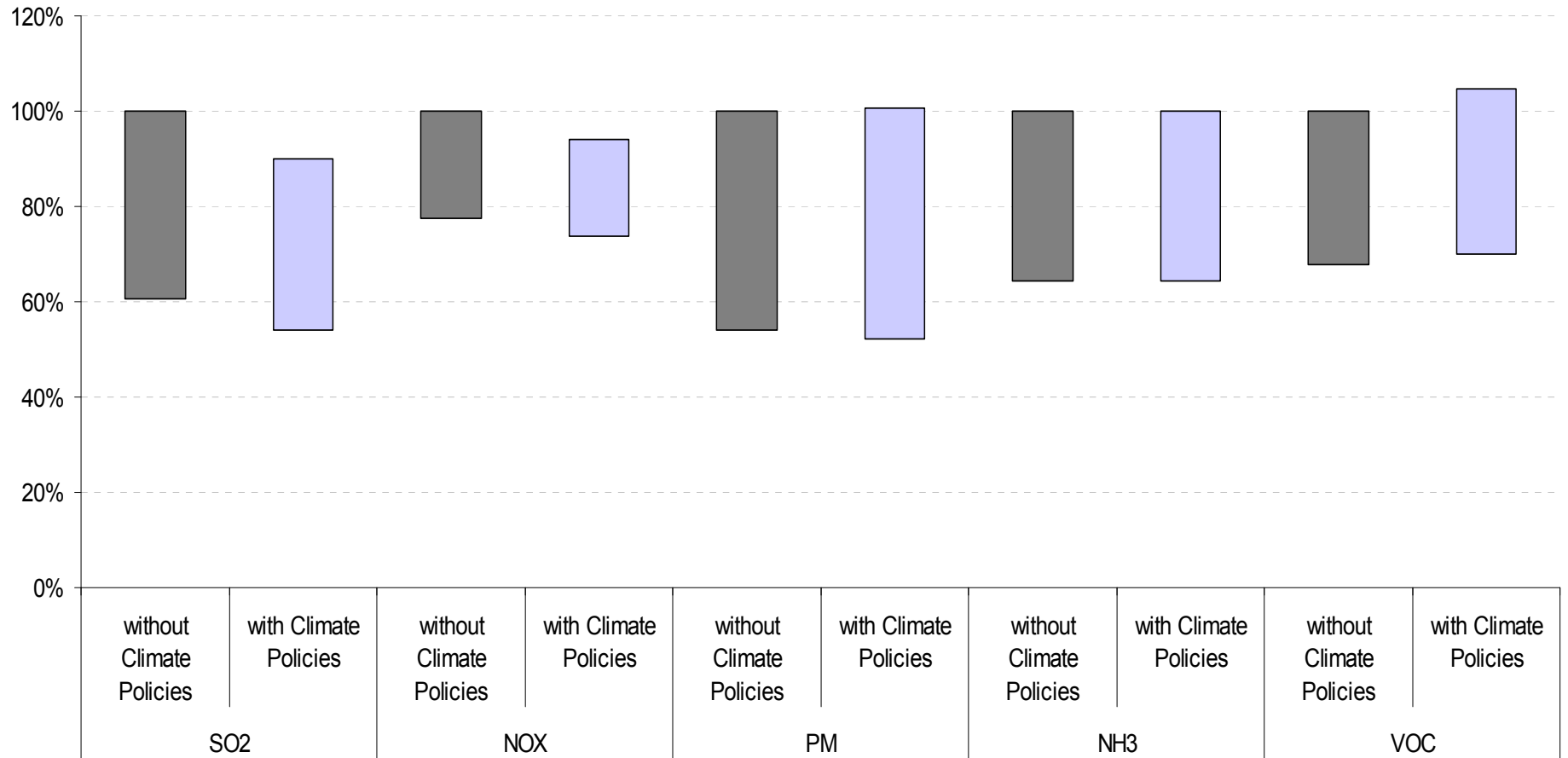


PM_{2.5}

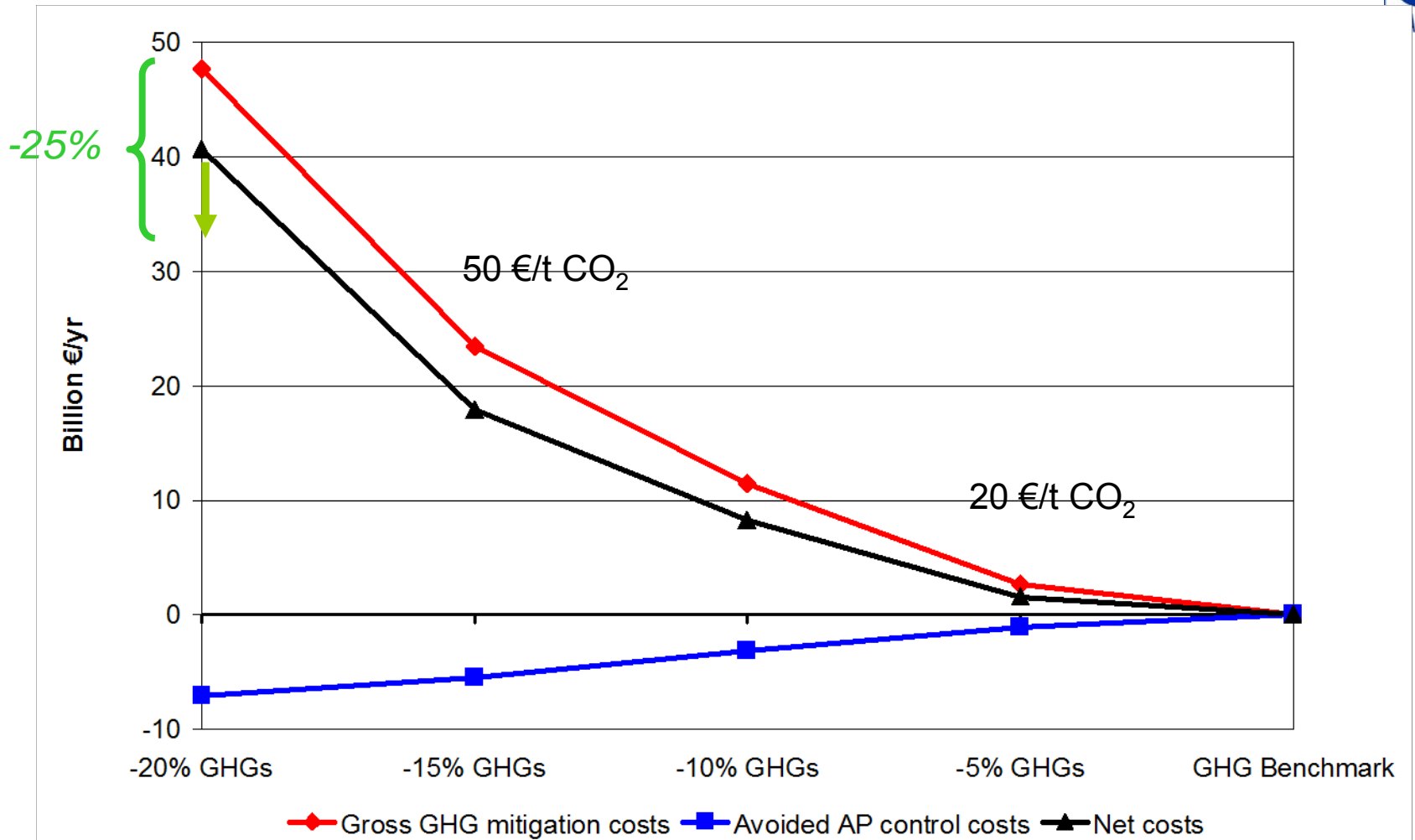


.... and potential trade-offs!!

CO2 reduction eases reduction of most air pollutants



Net costs of GHG mitigation considering cost savings from avoided current EU legislation air pollution control measures (EU25, 2020)



Summary



1. Interactions between AP and GHGs are important
2. There are many multi-pollutant measures
3. CO₂ reductions *typically* imply reductions of AP
4. There are potential co-benefits, but also trade-offs
5. Cost savings can be substantial
6. In GAINS air pollution and GHGs can be treated jointly to identify synergies and potential trade-offs

GAINS Web-interface

The screenshot displays the GAINS - Europe web interface. At the top, there is a navigation bar with the IIASA logo and the text "GAINS - Europe Greenhouse Gas and Air Pollution Interactions and Synergies". Below the navigation bar, there are links for "Login" and "Glossary". The main content area is divided into two columns. The left column contains a "GAINS online :: login" form with fields for "Username" (containing "Fabian") and "Password", a "Restore last work session" checkbox, and a "Login" button. Below the login form are links for "Read disclaimer", "Register", and "Links", with sub-links for "APD Web site" and "IIASA Web site". The right column features a "Welcome to the GAINS Model" heading, followed by a paragraph describing the model's purpose. Below this, there are two bulleted lists: one for "The model considers emissions of:" (including Carbon dioxide (CO₂), Methane (CH₄), Nitrogen oxides (NO_x), Nitrous oxide (N₂O), Particulate matter (TSP, PM₁₀, PM_{2.5} and PM₁), Sulfur dioxide (SO₂), and Volatile organic compounds (VOC)) and another for "Certain versions of the GAINS Model also contain:" (including Ammonia (NH₃), Carbon monoxide (CO), and Fluorinated greenhouse gases (F-Gases)). A final paragraph states "The GAINS Model consists of several screen options, which display information pertaining to:" followed by a bulleted list of options: "Economic Activity Pathways", "Emission Control Strategies", "Emissions Scenarios", "Emission Control Costs", "Impacts", and "Data Management". At the bottom, a small paragraph describes the model's simultaneous treatment of health and ecosystem impacts and greenhouse gas emissions.

www.iiasa.ac.at/rains/gains-online.html