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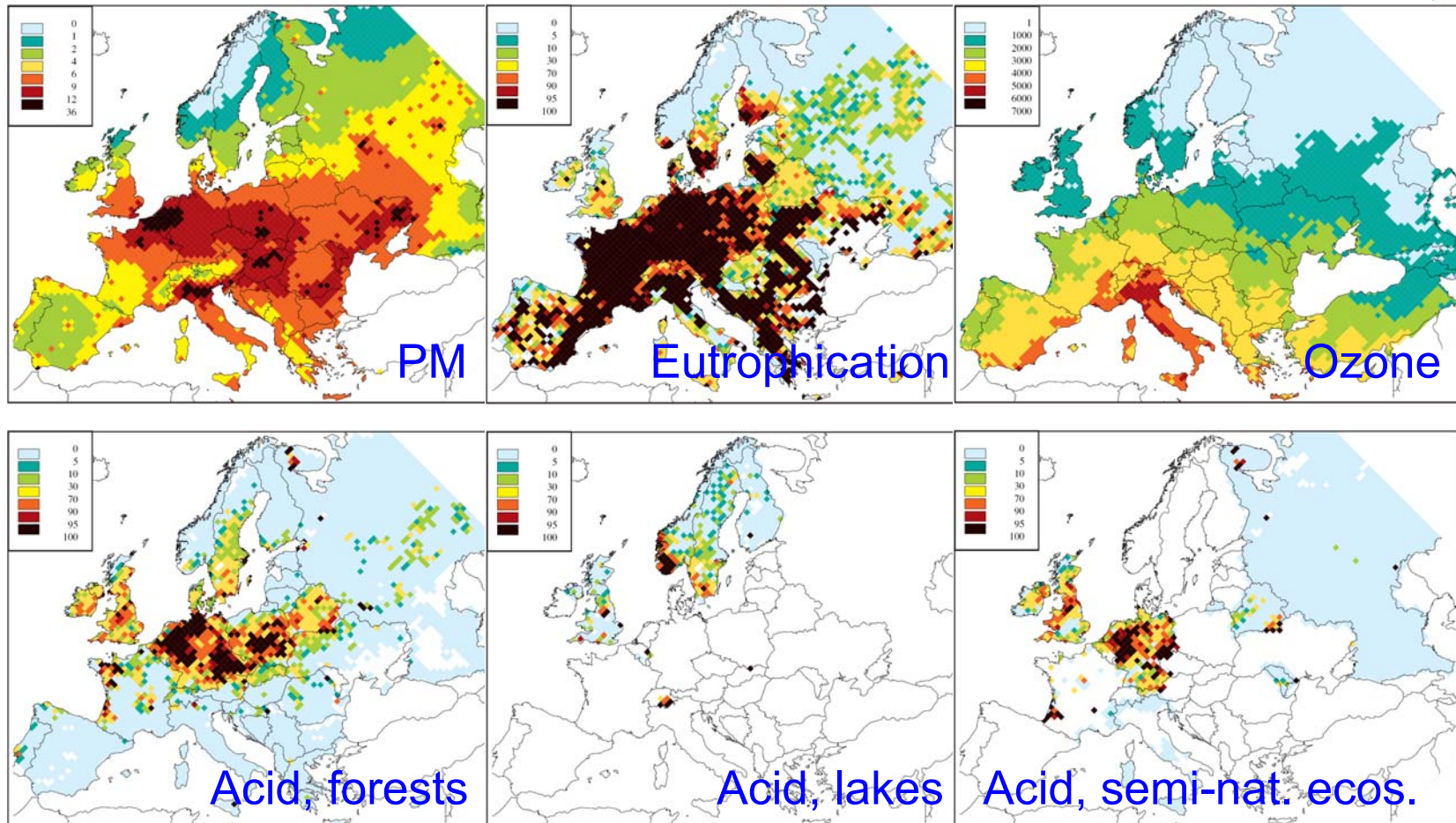


**Synergies  
between  
greenhouse gas mitigation  
and  
air pollution control  
in the  
European Union**

# The Greenhouse Gas-Air Pollution Interactions and Synergies model

## Environmental impacts of air pollution

### RAINS estimates for 2000



# The Greenhouse Gas-Air Pollution Interactions and Synergies model

## Multi-pollutant measures considered in GAINS (1)

*Trade-offs shown in red, GHGs are underlined*



- **Structural measures:**
  - Energy savings, efficiency improvements, bans: all pollutants ↓
  - Increased use of natural gas: CO<sub>2</sub>, SO<sub>2</sub>, VOC, NO<sub>x</sub>, PM ↓ CH<sub>4</sub> ↑
  - Biomass: CO<sub>2</sub> ↓ VOC, PM, CH<sub>4</sub> ↑
- **Stationary sources:**
  - SCR, SNCR: NO<sub>x</sub>, CO ↓, NH<sub>3</sub>, N<sub>2</sub>O, CO<sub>2</sub> ↑
  - Fluidized bed combustion: SO<sub>2</sub>, NO<sub>x</sub> ↓, N<sub>2</sub>O ↑
  - Advanced residential combustion: VOC, PM, CO, CH<sub>4</sub> ↓
  - FGD: SO<sub>2</sub>, PM ↓ CO<sub>2</sub> ↑
  - IGCC: CO<sub>2</sub>, SO<sub>2</sub>, NO<sub>x</sub>, PM ↓
  - CHP: all pollutants ↓
- **Mobile sources:**
  - Euro-standards: NO<sub>x</sub>, VOC, PM, CO ↓ NH<sub>3</sub>, N<sub>2</sub>O ↑
  - Low sulfur fuels: SO<sub>2</sub>, PM ↓
  - Diesel: CO<sub>2</sub>, VOC ↓, PM, NO<sub>x</sub>, SO<sub>2</sub> ↑

# The Greenhouse Gas-Air Pollution Interactions and Synergies model

## Multi-pollutant measures considered in GAINS (2)

*Trade-offs shown in red, GHGs are underlined*



- **Agricultural sources:**

- Low emission pig housing –  $\text{NH}_3$ ,  $\text{CH}_4$  ↓  $\text{N}_2\text{O}$  ↑
- Covered storage of slurry –  $\text{NH}_3$  ↓  $\text{CH}_4$  ↑
- Injection of manure –  $\text{NH}_3$  ↓  $\text{N}_2\text{O}$  ↑
- Anaerobic digestion (biogas) –  $\text{CH}_4$ ,  $\text{N}_2\text{O}$  ↓  $\text{CO}_2$  ↑  $\text{NH}_3$  ↓ ↑

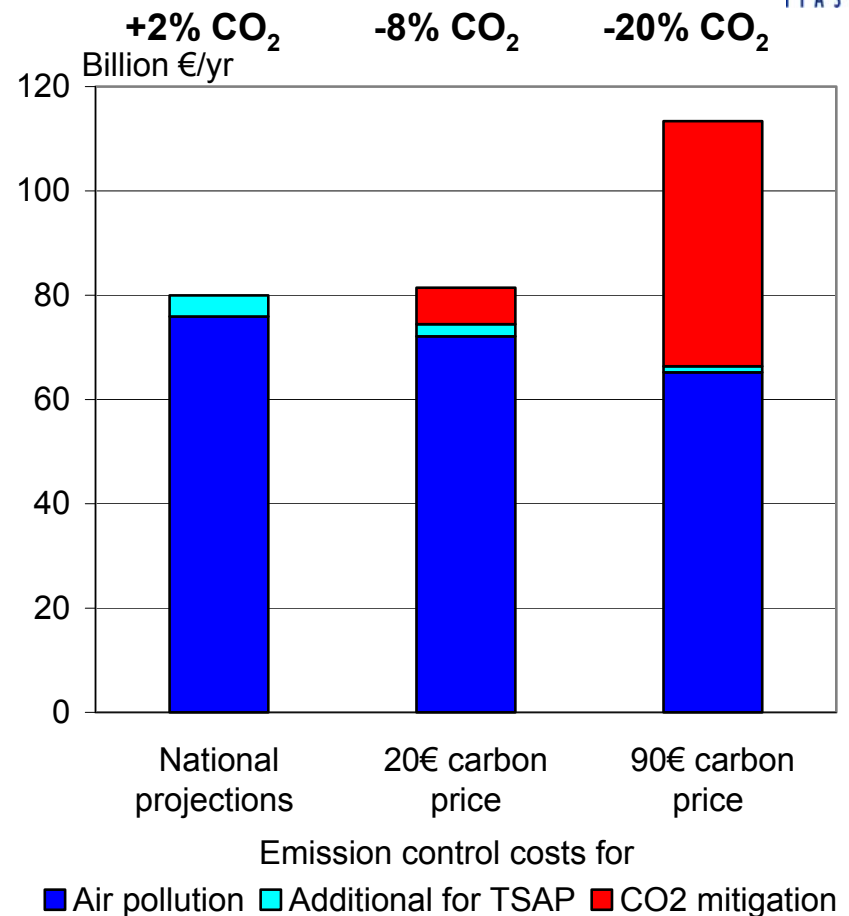
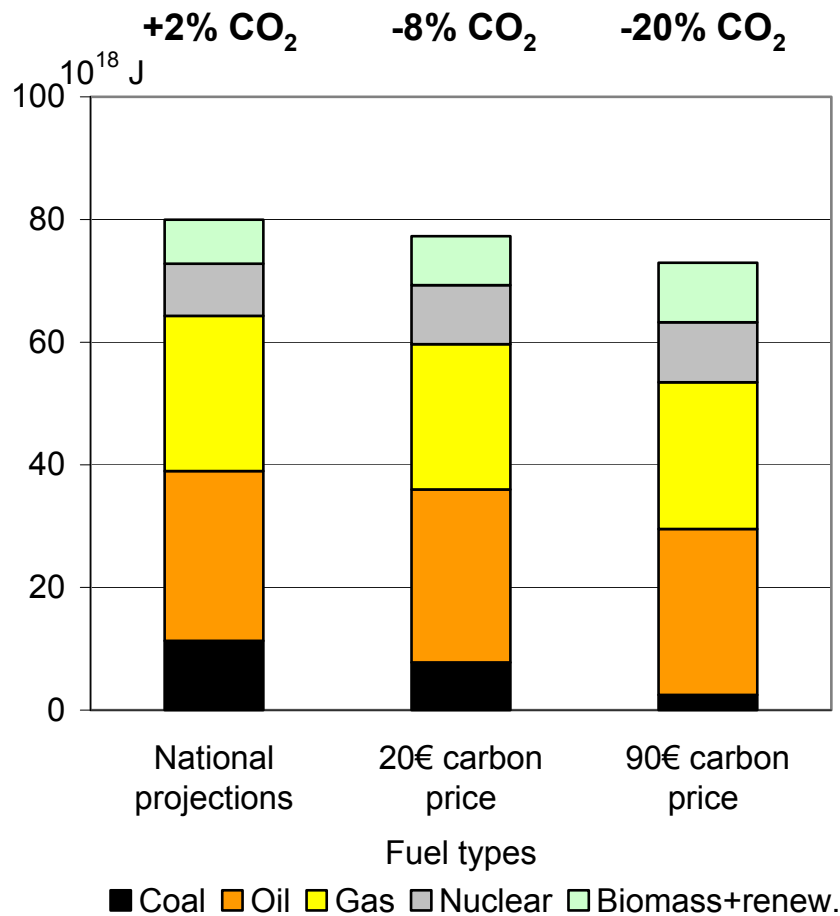
- **Other sources**

- Gas recovery and flaring:  $\text{CH}_4$  ↓  $\text{CO}_2$ , PM, VOC,  $\text{SO}_2$ ,  $\text{NO}_x$ , CO ↑
- Gas recovery and re-use:  $\text{CH}_4$  ↓  $\text{CO}_2$  ↑
- Improving flaring efficiency: PM, VOC,  $\text{NO}_x$ ,  $\text{SO}_2$ , CO ↓
- Waste incineration:  $\text{CH}_4$  ↓  $\text{CO}_2$  ↑
- Gas recovery from wastewater treatment:  $\text{CH}_4$  ↓  $\text{CO}_2$  ↑

In total approx. 500 measures with multi-pollutant impacts considered in GAINS

# Energy consumption and emission control costs

## EU-25, 2020, GAINS estimates



# Conclusions

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Greenhouse gas mitigation leads to substantial cost savings for achieving air quality targets.

An accurate appraisal of GHG mitigation potentials and costs requires an integrated perspective:

- to avoid double-counting of costs,
- to reveal win-win measures,
- to identify trade-offs, *inter alia* for
  - enhanced use of biofuels,
  - diesel vehicles,
  - reduction of SO<sub>2</sub> emissions