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The inclusion of  
black carbon into a  
multi-pollutant/multi-effect  
emission control framework

EPA Workshop on

‘Addressing Black Carbon and Ozone as Short-lived Climate Forcers’

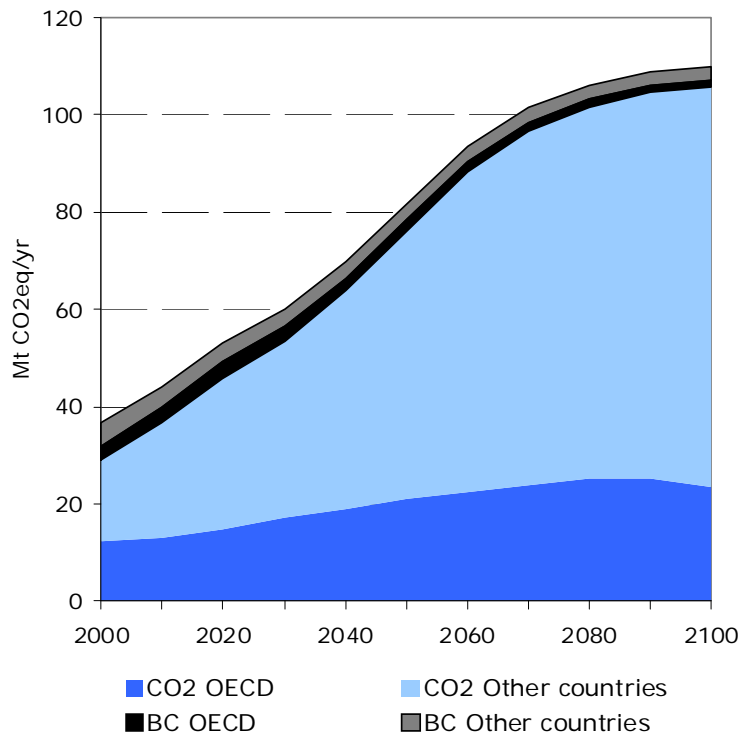
Chapel Hill, March 3-4, 2010

# Option 1: Assigning a $GWP_{100}$ to BC

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## Global CO<sub>2</sub> and BC emissions RCP 8.5 scenario, $GWP_{BC}=1000$



## A GWP would put BC on the same scale with CO<sub>2</sub>

- Scientific uncertainties about the quantification of radiative forcing of BC
- A single spatial and time scale for long- and short-lived gases is a questionable compromise in view of their effects
- Possibility of trading BC against CO<sub>2</sub> reductions is politically controversial as it might divert attention from the need for reduction of long-lived gases

## Option 2:

# Considering near-term climate impacts as an additional effect of air pollutants

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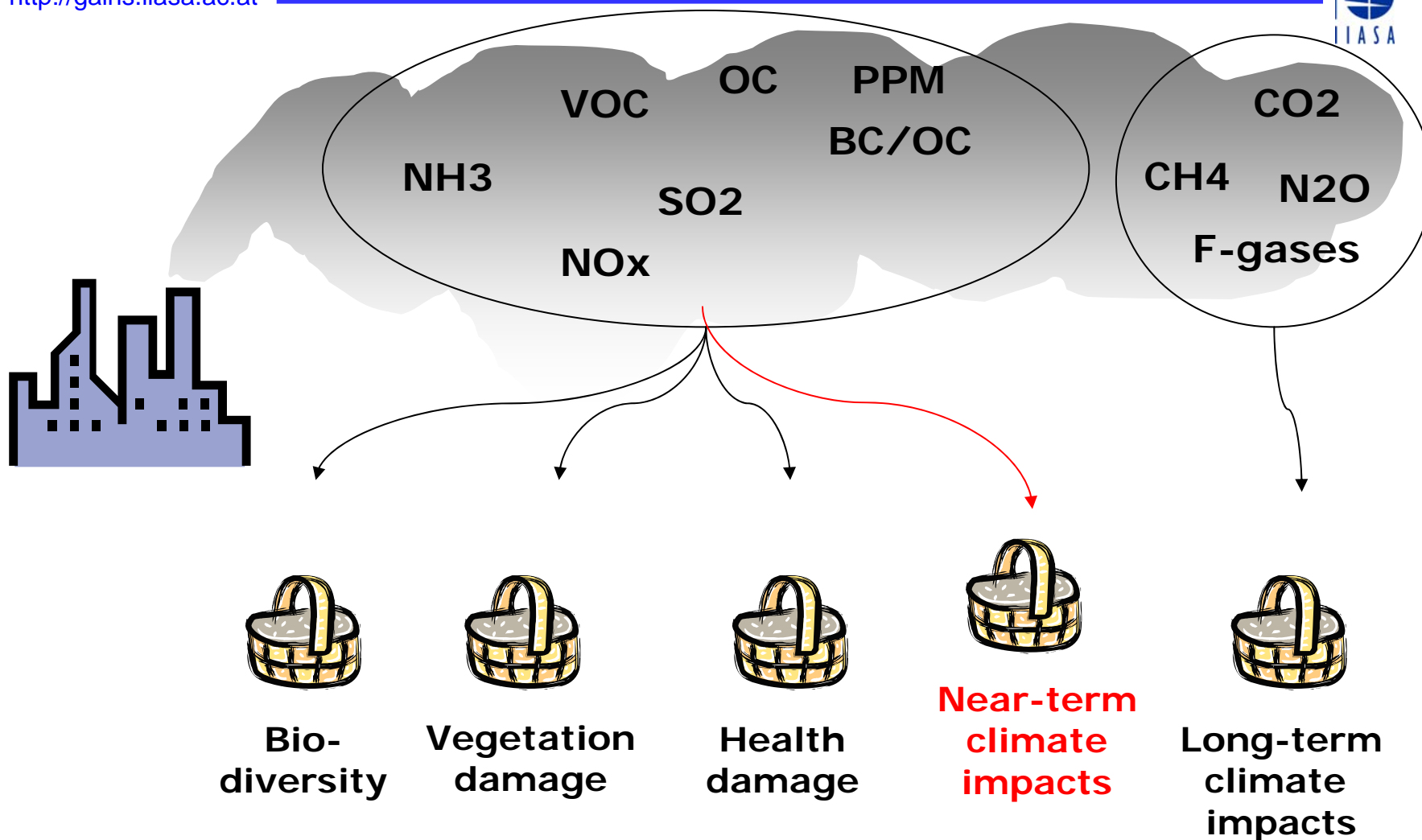


- Near-term forcing of air pollutants
  - Warming: BC, O<sub>3</sub> (i.e., CH<sub>4</sub>, CO, NO<sub>x</sub>, VOC)
  - Cooling: SO<sub>2</sub>, OC
  - accelerates or delays ongoing climate change at the regional scale,
  - changes regional weather circulation and precipitation patterns.
- Accelerated melting of Arctic ice and glaciers through deposition of (black) carbon

could be considered as an additional effect of air pollutants  
(on top of their health and ecosystems impacts)

# A two-baskets approach for climate impacts

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# The GAINS multi-pollutant/multi-effect framework

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## Cost-effective mitigation measures

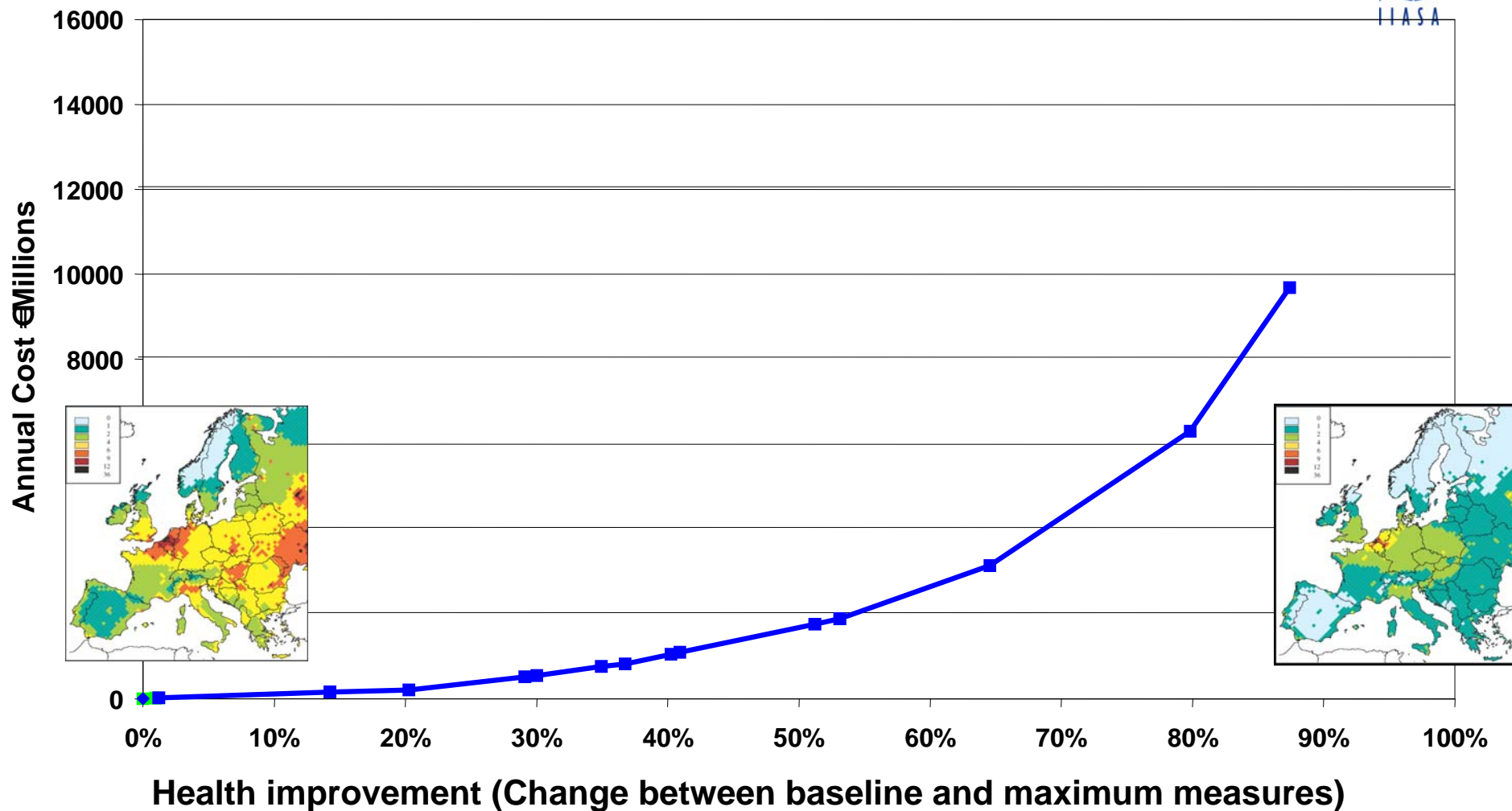
	PM	SO <sub>2</sub>	NO <sub>x</sub>	VOC	NH <sub>3</sub>	CO <sub>2</sub>	CH <sub>4</sub>	N <sub>2</sub> O	HFCs	PFCs	SF <sub>6</sub>
<b>Health impacts:</b>											
PM (Loss in life expectancy)	✓	✓	✓	✓	✓						
O <sub>3</sub> (Premature mortality)			✓	✓							
<b>Vegetation damage:</b>											
O <sub>3</sub> (AOT40/fluxes)			✓	✓							
Acidification (Excess of critical loads)		✓	✓								
Eutrophication (Excess of critical loads)			✓								
<b>Climate impacts:</b>											
Long-term (GWP100)						✓	✓	✓	✓		

**Environmental targets**

# Costs for reducing health impacts from fine PM

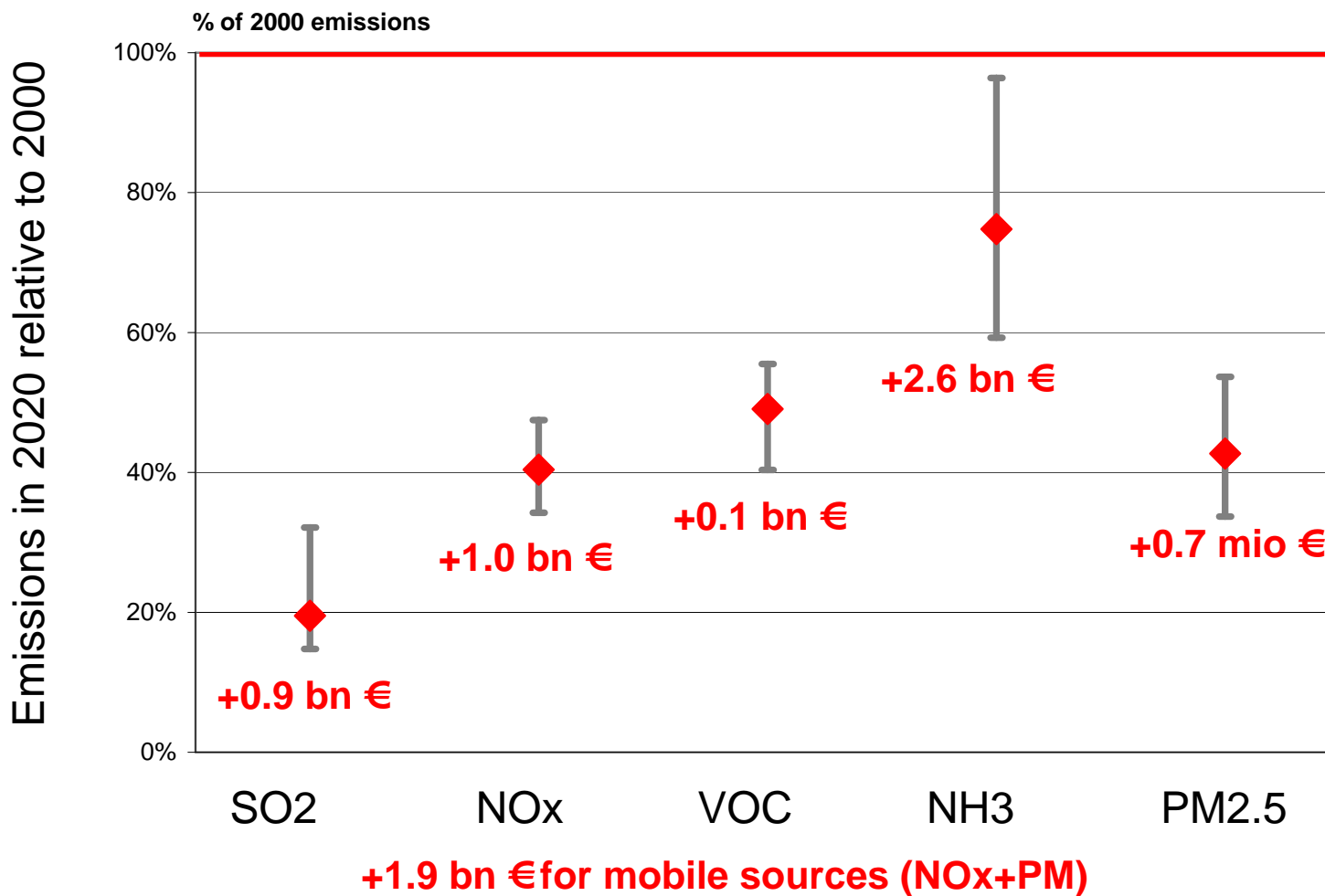
## Analysis for the EU Clean Air For Europe (CAFE) programme

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# Emission reductions suggested by the EU Thematic Strategy for Air Pollution

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# Potential approaches for GAINS optimization for the CLRTAP Gothenburg protocol

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Starting from an energy scenario that achieves given (long-term) climate objectives (expressed through  $GWP_{100}$ ):

## Option 1:

- Optimize for targets on
  - health and ecosystems (as before),
  - near-term forcing and carbon deposition to the Arctic.

## Option 2:

- Optimize for targets on
  - health and ecosystems (as before),
  - with maximum co-benefits on short-term forcing.

# Potential impact indicators

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- As there is significant scientific uncertainty on the quantification of actual climate impacts, indicators should refer to physical indicators that can be quantified with some kind of robustness.
- Potential metrics (impact indicators):
  1. **Instantaneous radiative forcing of sustained emissions**  
(at regional and global scales)
  2. **Deposition of (black) carbon in the Arctic and on glaciers.**
- These metrics would not interfere with UNFCCC objectives (long-term stabilization, reflected through 100 years GWP)
- As they do not involve CO<sub>2</sub>, no conflict between control of air pollutants and CO<sub>2</sub> mitigation could be constructed

# Required information for (European) implementation

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- Development of cost curves for BC, OC, CO
- Quantification of source-impacts relationships (between national emissions and regional forcing)
  - Calculation of source-receptor relationships between (country) precursor emissions and (grid) column concentrations (EMEP/MSC-W)
  - Estimation of (regional) radiative forcing from (grid) column concentrations (Uni.Oslo)
- Extension of GAINS optimization routine

Prototype implementation planned for 2010,  
full implementation and validation thereafter

# Important features

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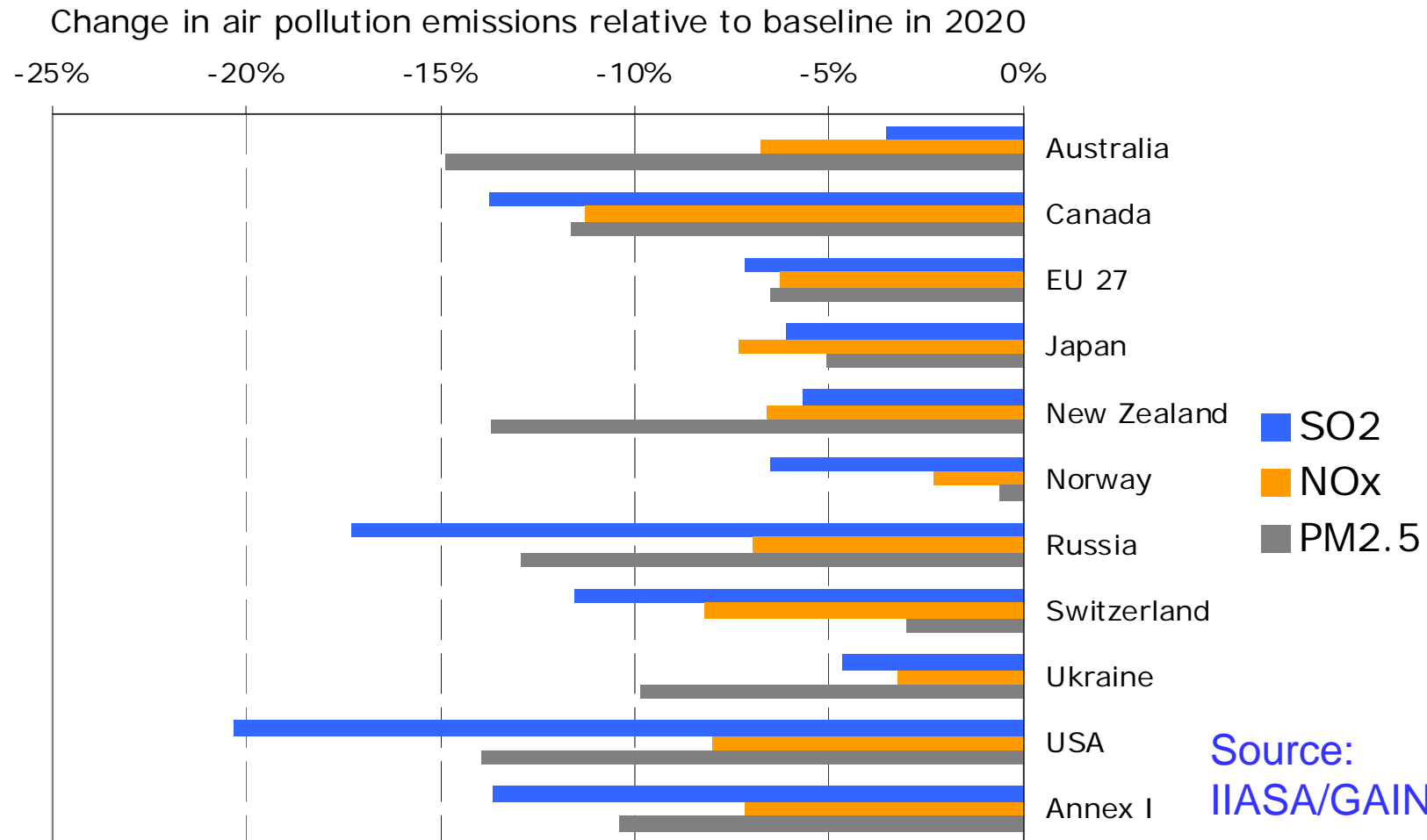
Such an approach would

- as a side effect, increase robustness of health impact strategies (preferential treatment of BC vs other PM2.5 components),
- consider co-controls
  - between short-lived forcers,
  - between short- and long-lived substances.

# Co-control of GHGs and air pollutants in Annex I

## Change in air pollution emissions of the high pledges for COP15

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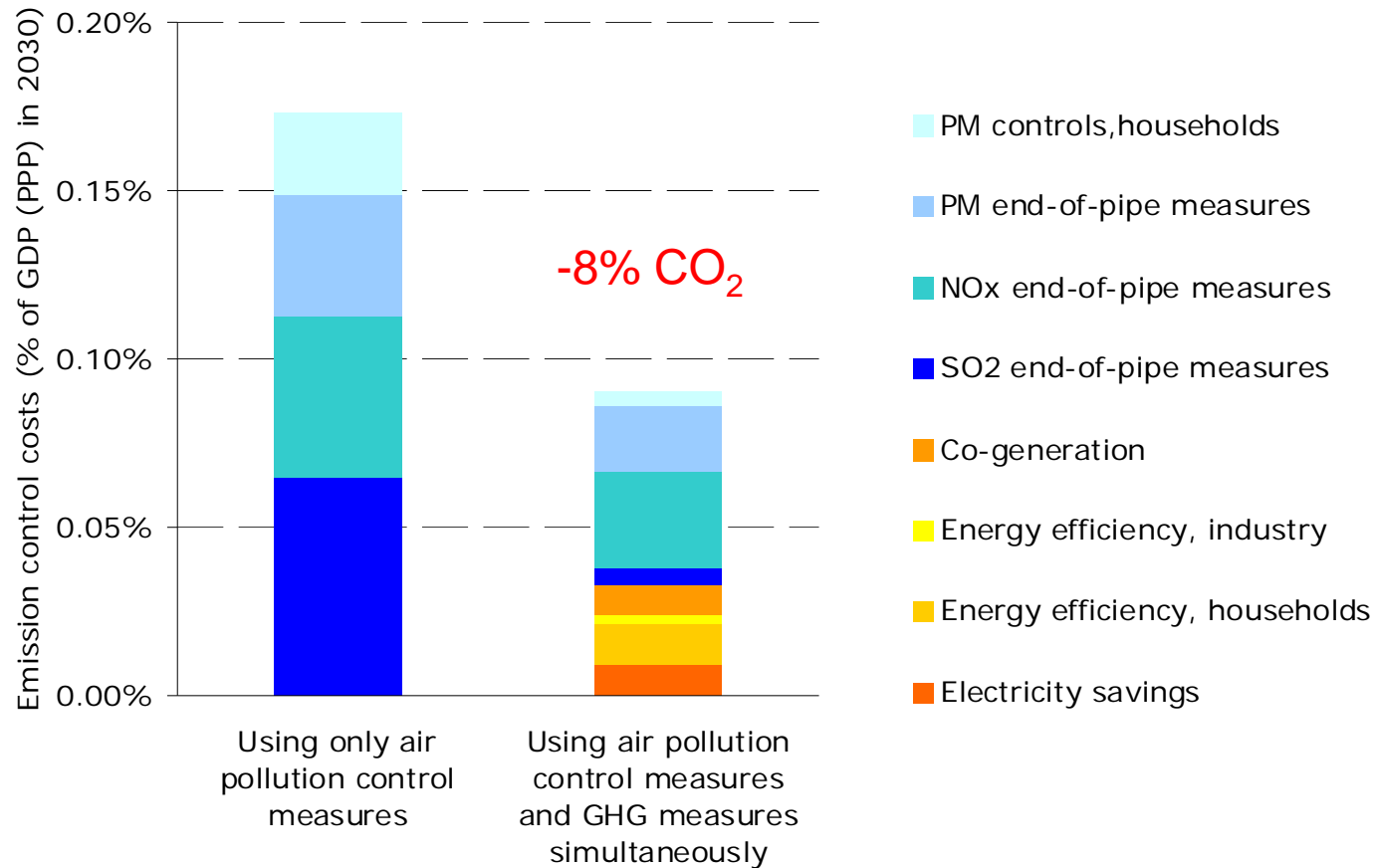


# Well-designed air pollution control strategies can also reduce GHG emissions

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## Emission control costs for reducing PM health impacts in China by 50%



# Conclusions

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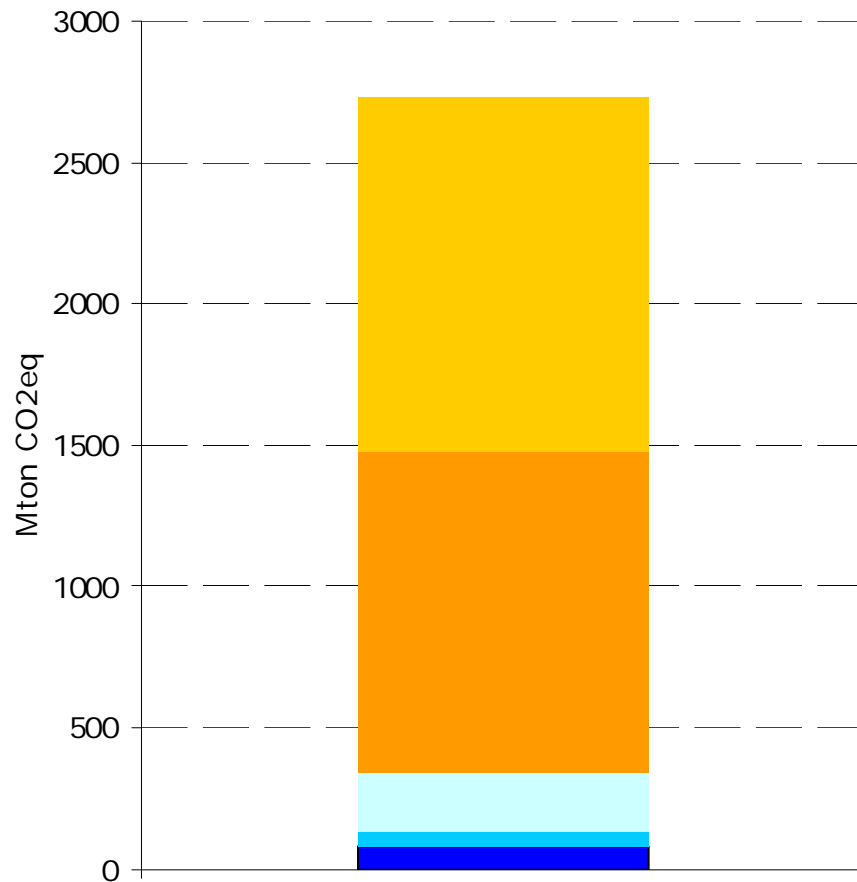
- Near-term forcing and carbon deposition to ice sheets could be included as an additional effect of air pollutants into the GAINS multi-pollutant/multi-effect cost-effectiveness analysis
- Suggested metrics:
  - Instantaneous radiative forcing at the regional/global scale
  - Carbon deposition to ice sheets
- In a first step, such information could be used to prioritize reductions of precursor emissions to reduce PM2.5 levels
- In addition, there are sizeable synergies between the control of long- and short-lived substances
- More info: <http://gains.iiasa.ac.at>

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# Should methane be included in this basket?

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CH<sub>4</sub> mitigation potential  
in 2020 < 40 €/ton CO<sub>2</sub>eq

- Rest of World
- China
- Other Annex1
- EU-27
- USA

GAINS estimate