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International Institute for Applied Systems Analysis (IIASA)

Regional framework on transboundary air pollution;

Can integrated assessment models help?

International Conference on
Transboundary Air Pollution in North-East Asia
Tokyo, December 17-19, 2008

Economic development and air pollution

IIASA

Economic development ↑

… to global
climate change

… and regional pollution …

… over urban smog …

From indoor pollution …

Scale of pollution →

Outline

- UN CLRTAP and European Union regional air quality frameworks and agreements
- Role of integrated assessment models (IAM) in development of:
  - Gothenburg Protocol
  - Clean Air for Europe (CAFE)
  - EU National Emission Ceilings Directive (NECD)
- Synergies and trade-offs between the control of regional air pollution and the mitigation of GHG emissions
- GAINS – *Asia*
- Conclusions

Air pollution policy process in Europe

1979: **UN/ECE Convention on Long-range Transboundary Air Pollution (CLRTAP) signed**

1981: **European Monitoring and Evaluation Programme (EMEP) established**

1985-1994: **A number of Protocols signed under the CLRTAP; SO_2, NO_x, NMVOC, HM**

1997: **EU Acidification Strategy**

1999: **Protocol to Abate Acidification, Eutrophication and Ground-level Ozone of CLRTAP**
(Gothenburg Protocol – ratified 17 May 2005)

2001: **EU National Emission Ceilings (NEC) Directive**
(SO_2, NO_x, NH_3, NMVOC)

2005: **EU Clean Air For Europe (CAFE) strategy proposed**
(includes for the first time targets for Particulate Matter emissions)

2008: **Review of the EU NEC Directive**

2008-2009: **Review of the Gothenburg Protocol**

Air quality management through integration

The LRTAP Convention and European Union (CAFE and NEC) achieved integration across:

- Geographical regions
- Environmental effects
- Pollutants
- Economic development and environmental objectives
- Economic sectors
- Science and policy making

- Different policy areas

Integrating over regions:

51 Parties to the LRTAP Convention

UNITED NATIONS ECONOMIC COMMISSION FOR EUROPE

Clean Air for Europe (CAFE) – *2001-2005*

Objective:

European Commission CAFE programme's goal is to develop a long-term, strategic and integrated policy to protect against the effects of air pollution on human health and the environment

Priorities:

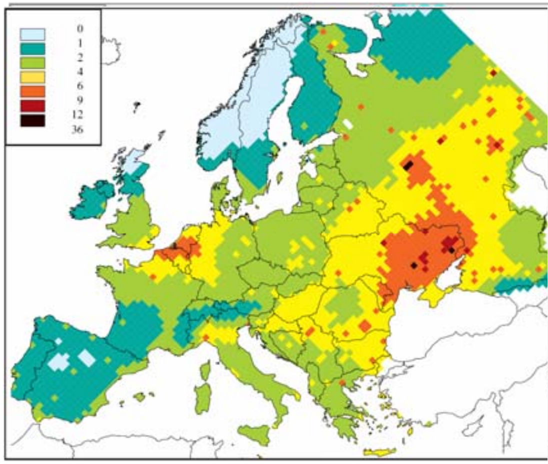
Particulate matter and ozone

Setup:

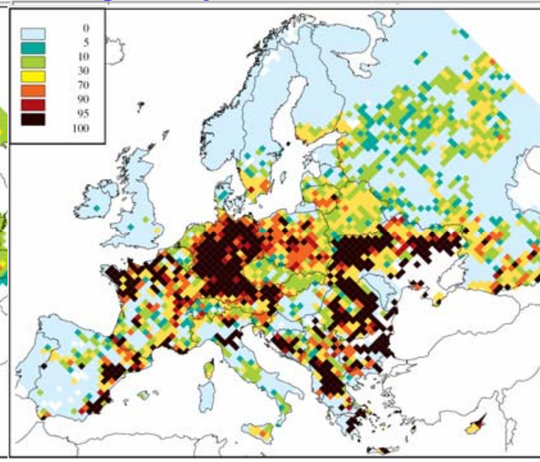
- CAFE secretariat
- CAFE Working Groups
- stakeholder consultations
- consultants

Integrating over different effects:
Air quality impacts in 2000 and policy for 2020

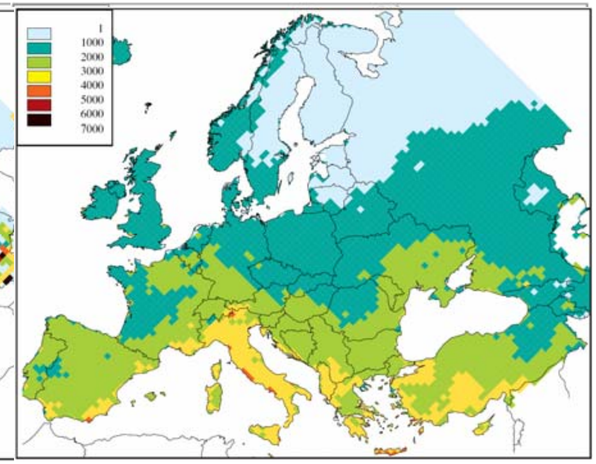
Health impacts from fine PM

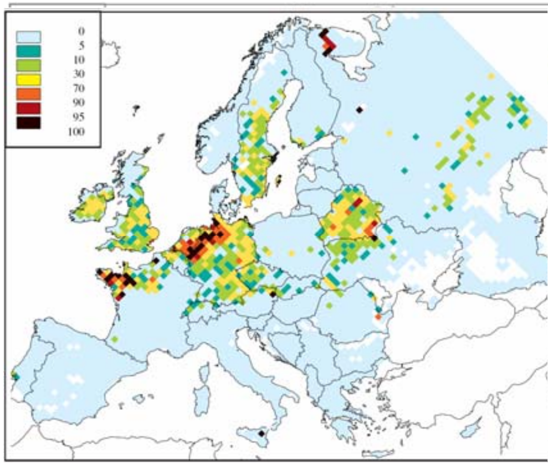


Biodiversity threat from excess nitrogen deposition

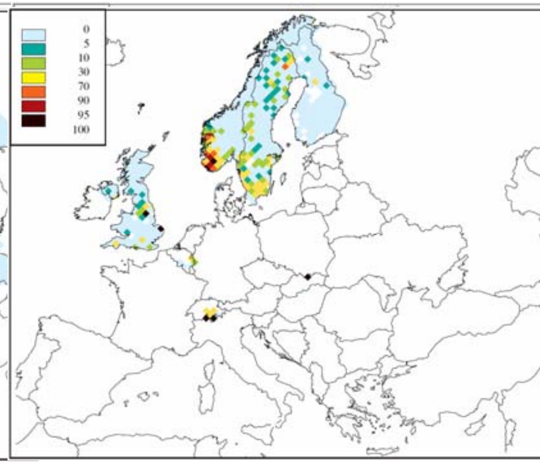


Health impacts from ozone

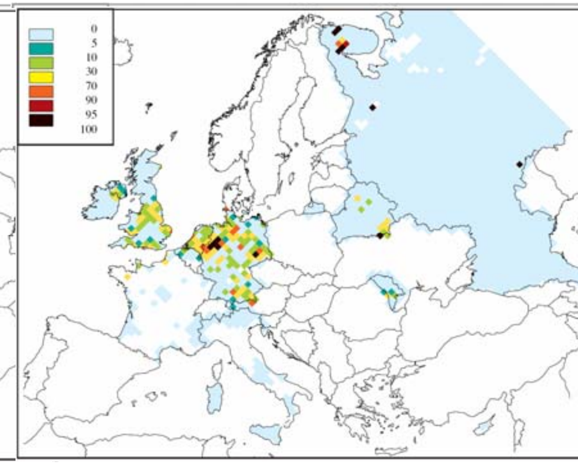




Acidification of forest soils



Acidification of rivers and lakes



Acidification of nature protection areas

Integrating over pollutants:

The multi-pollutant/multi-effect approach of air pollution control in Europe

	PM	SO_2	NO_x	VOC	NH_3
Health impacts: PM	√	√	√	√	√
O_3			√	√	
Vegetation damage: O_3			√	√	
Acidification		√	√		√
Eutrophication			√		√

Integrating environmental objectives and economic development:

The cost-effectiveness approach

Minimize total emission control costs

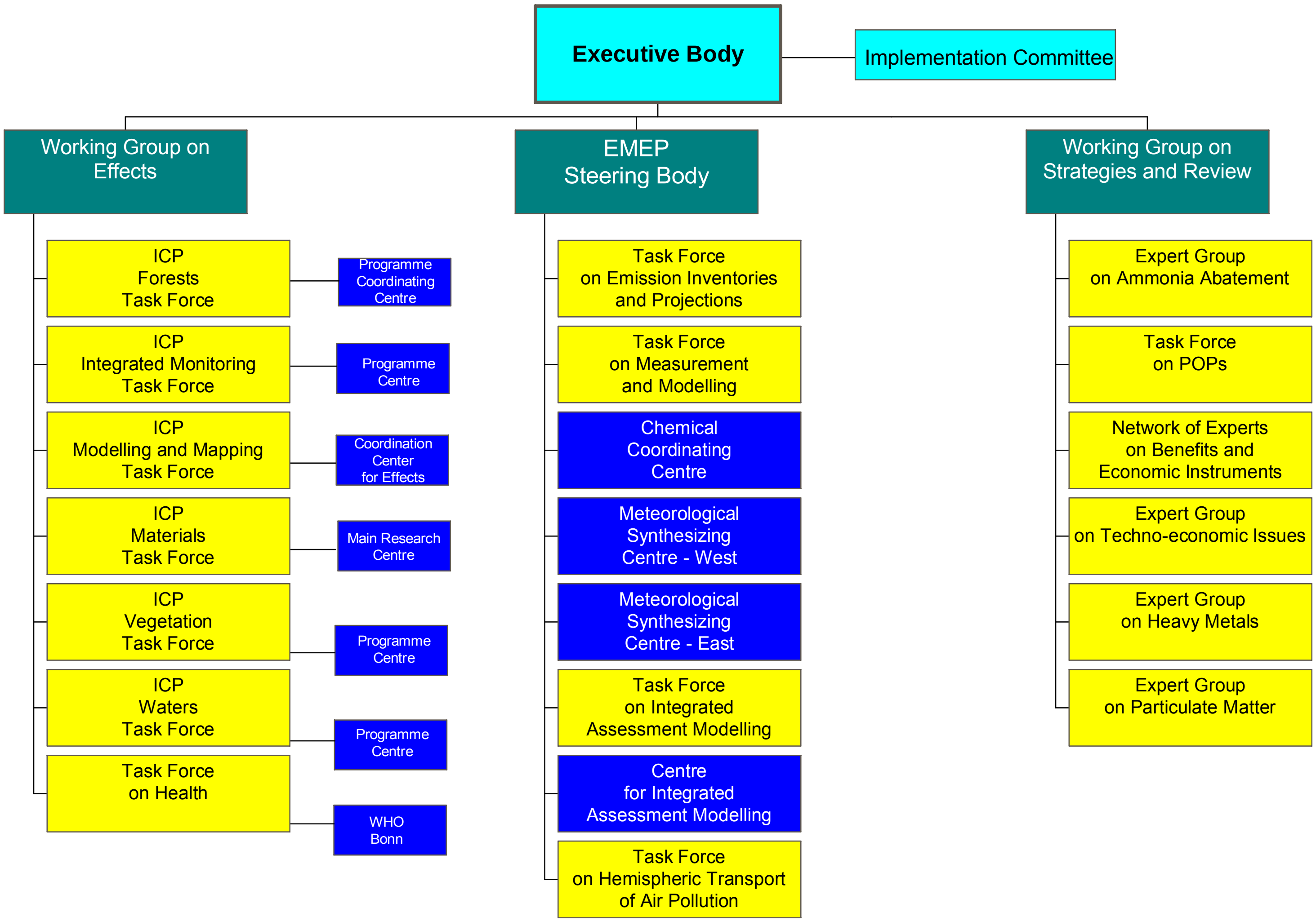
Environmental policy targets

Optimization

	PM	O_2	NO_x	VOC	NH_3
Health impacts: PM	√		√	√	√
O_3			√	√	
Vegetation damage: O			√	√	
ication		√	√		√
Eu			√		√

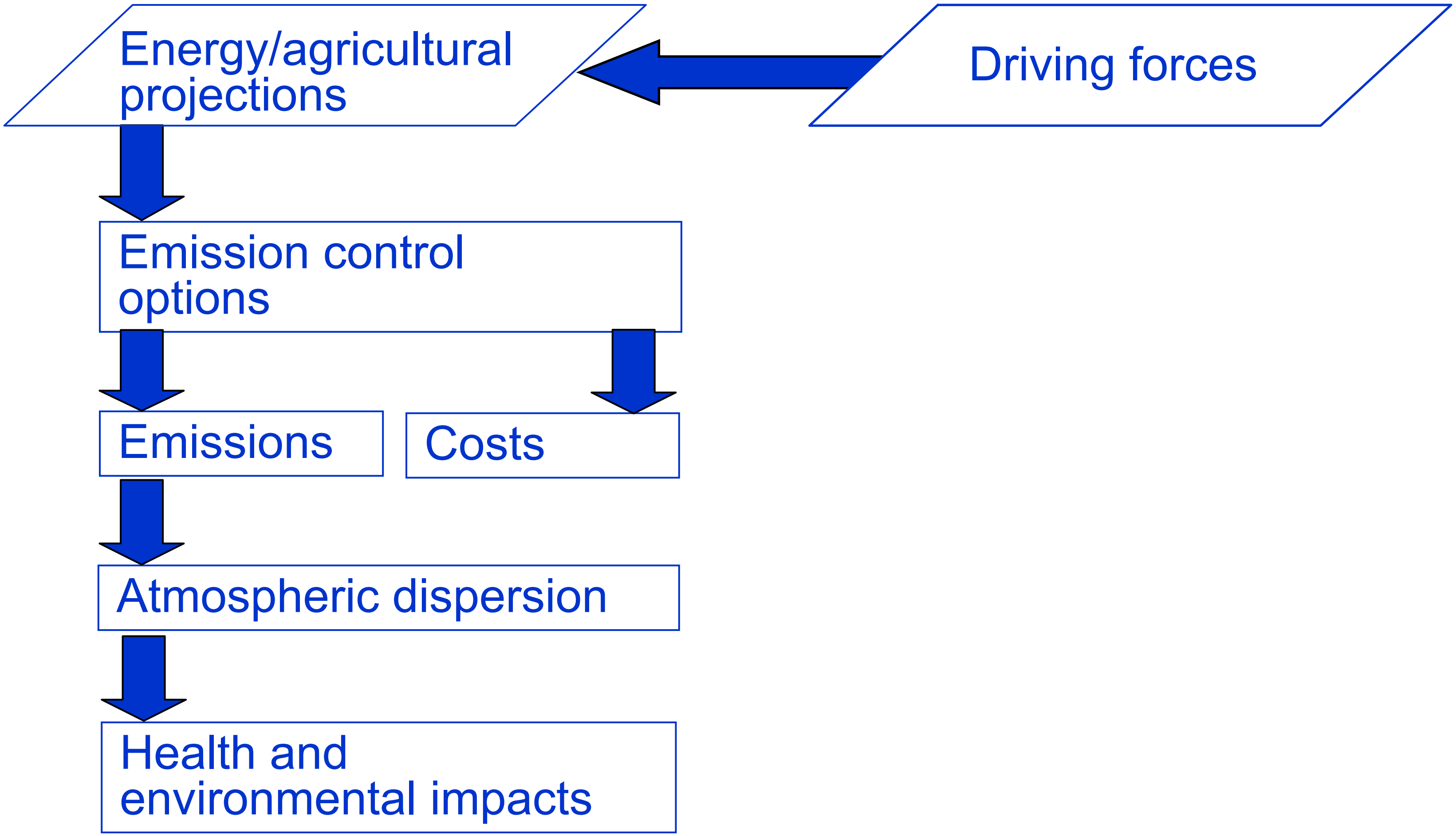
Integrating science and policy making:

The working structure of CLRTAP

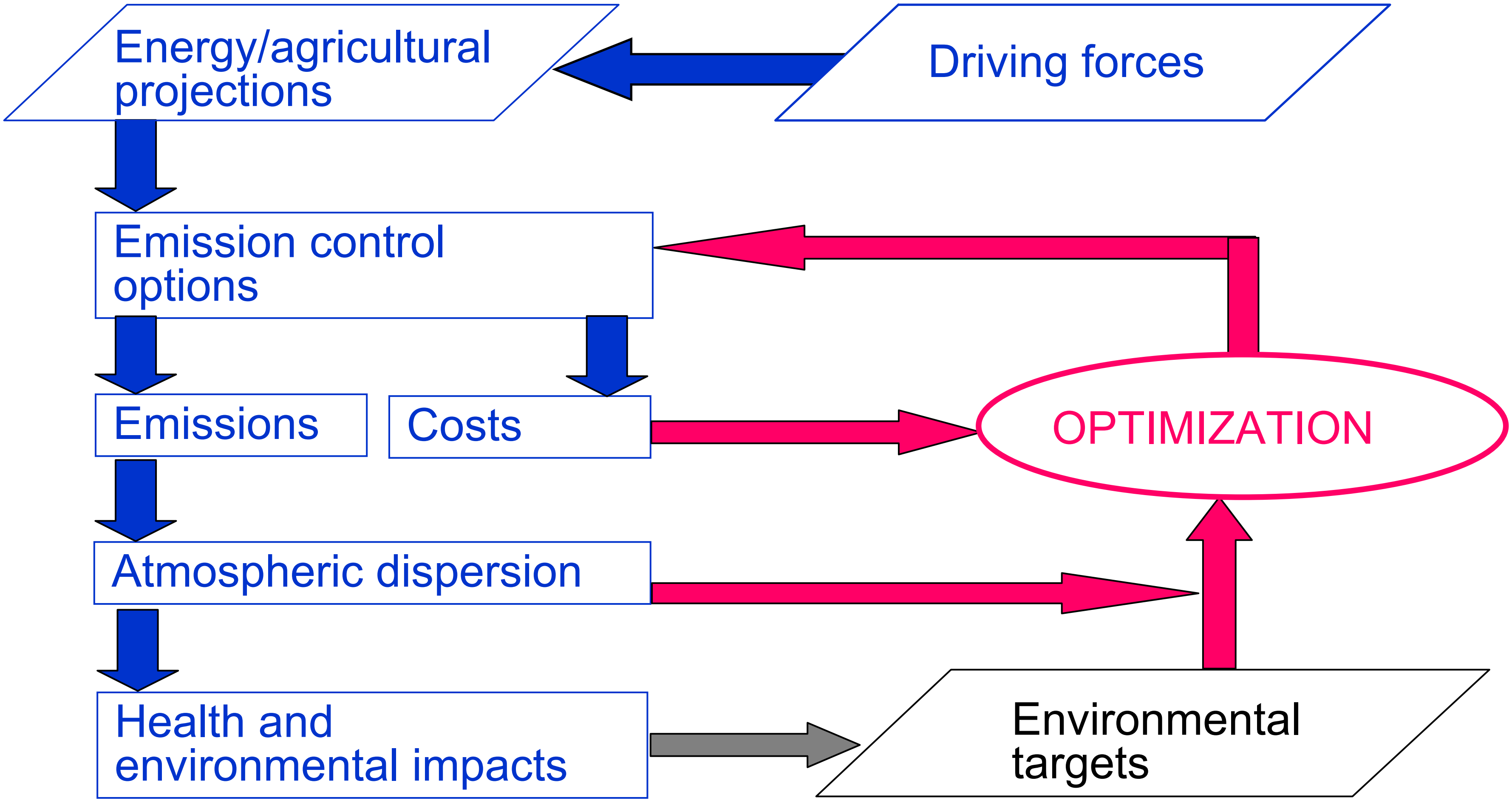


The tool for the integrated assessment

The RAINS model developed by IIASA



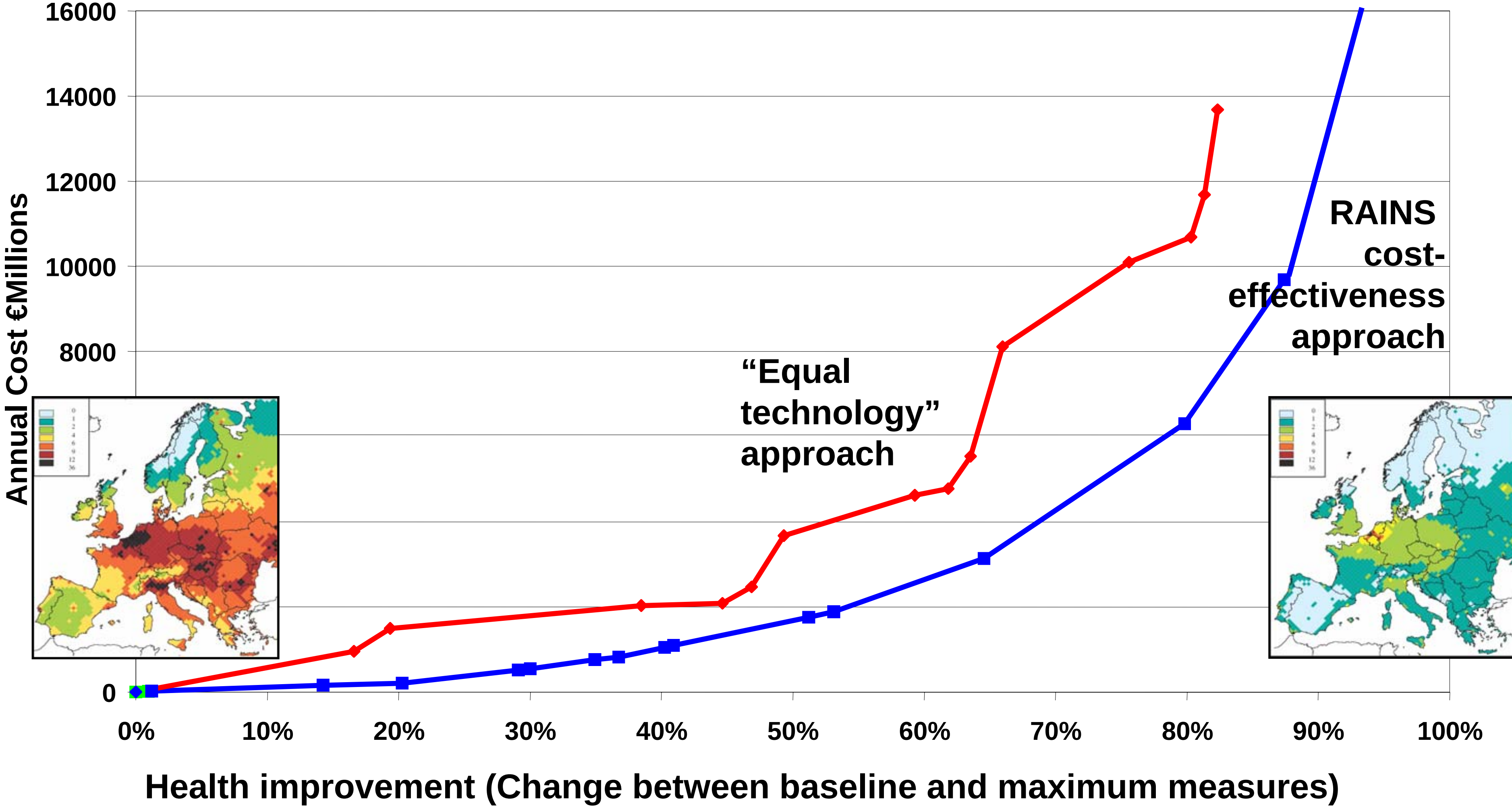
The cost-effectiveness approach
as an iterative policy process



Cost savings from the RAINS approach

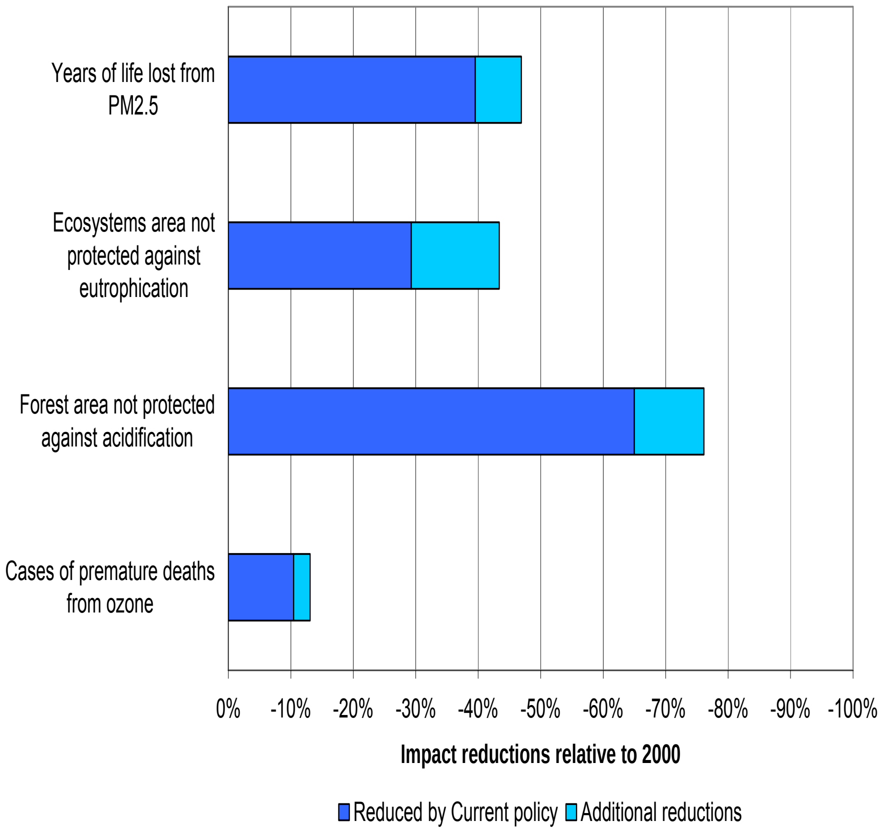
Estimates presented by European industry associations

Courtesy of Les White

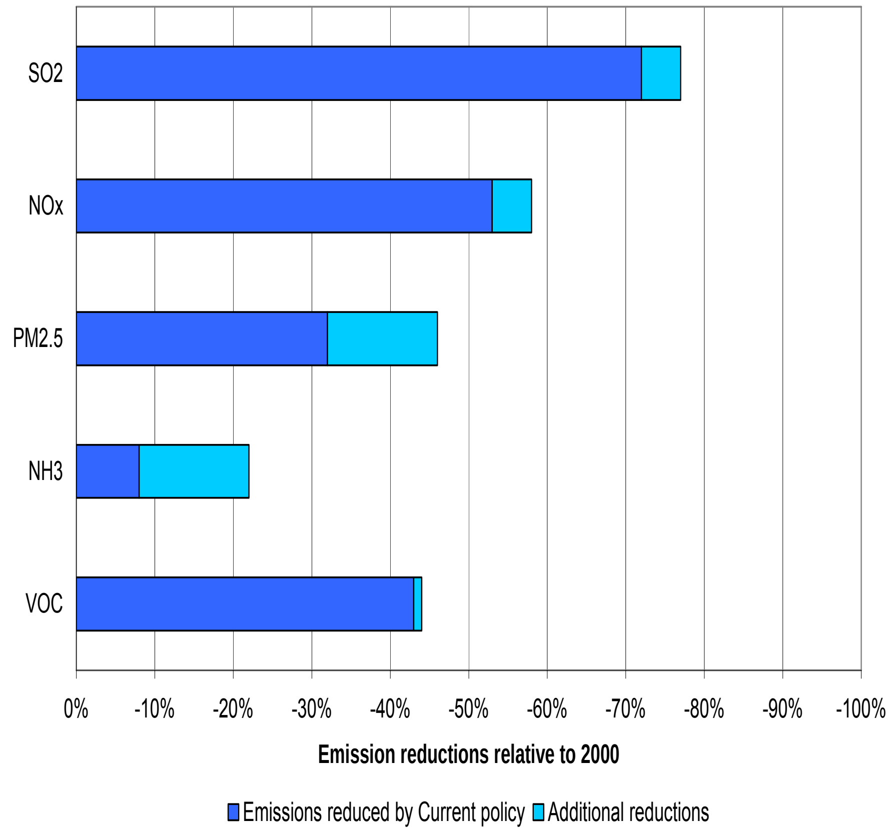


Environmental improvements and emission reductions, NEC review central case, EU-27, 2020

Environmental improvements

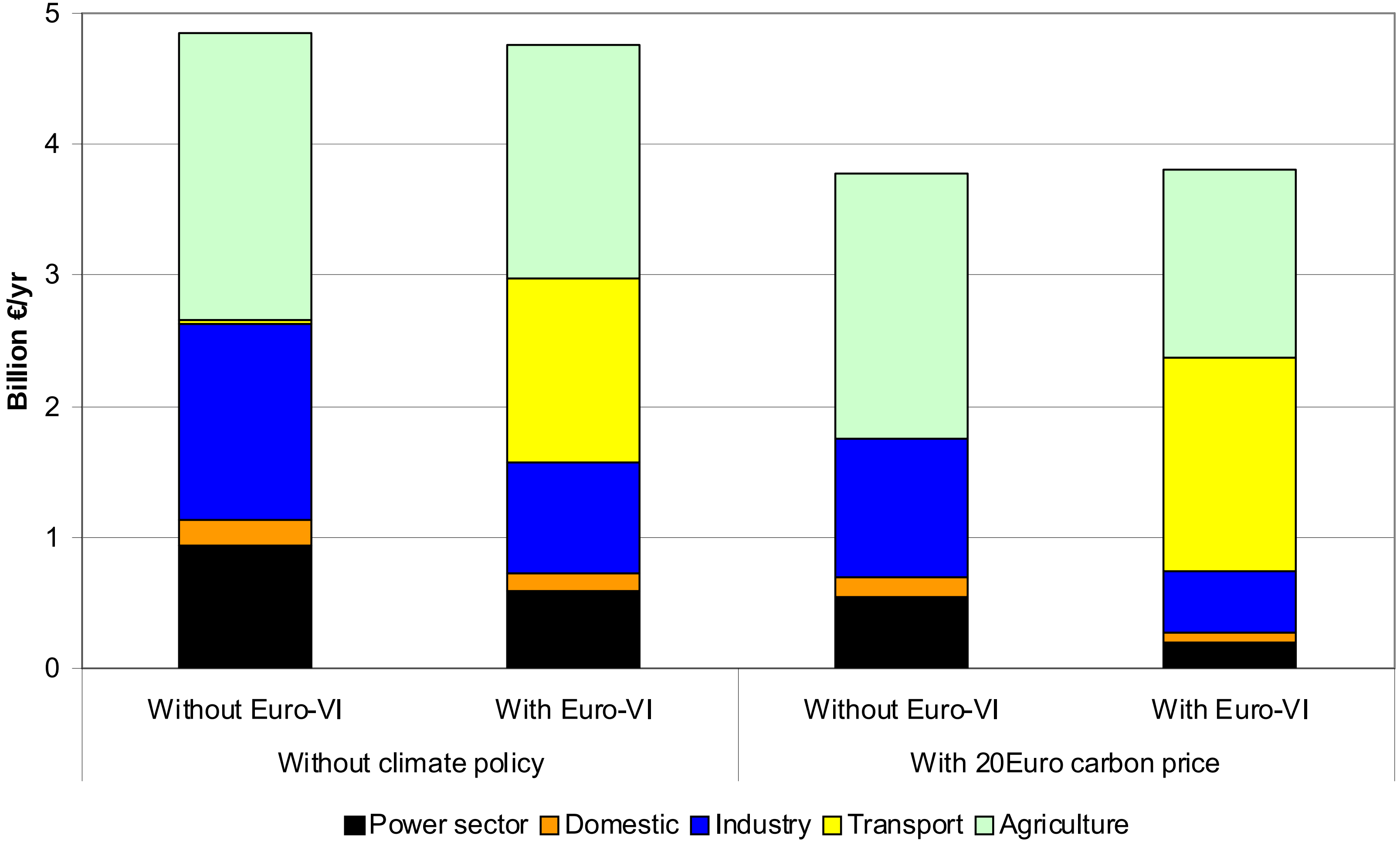


Emission reductions



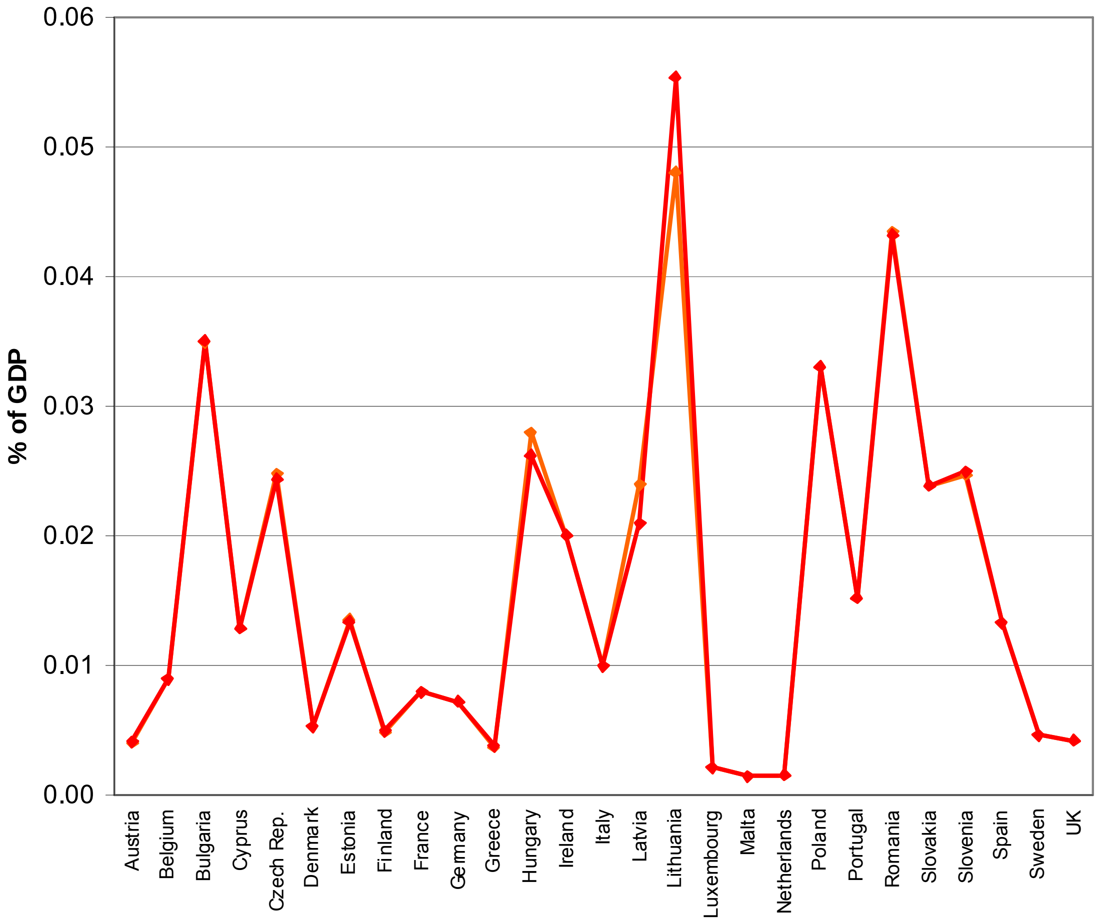
Integrating over economic sectors:

Costs of the EU Thematic Strategy on Air Pollution



Air pollution control costs 2020
on top of current policy

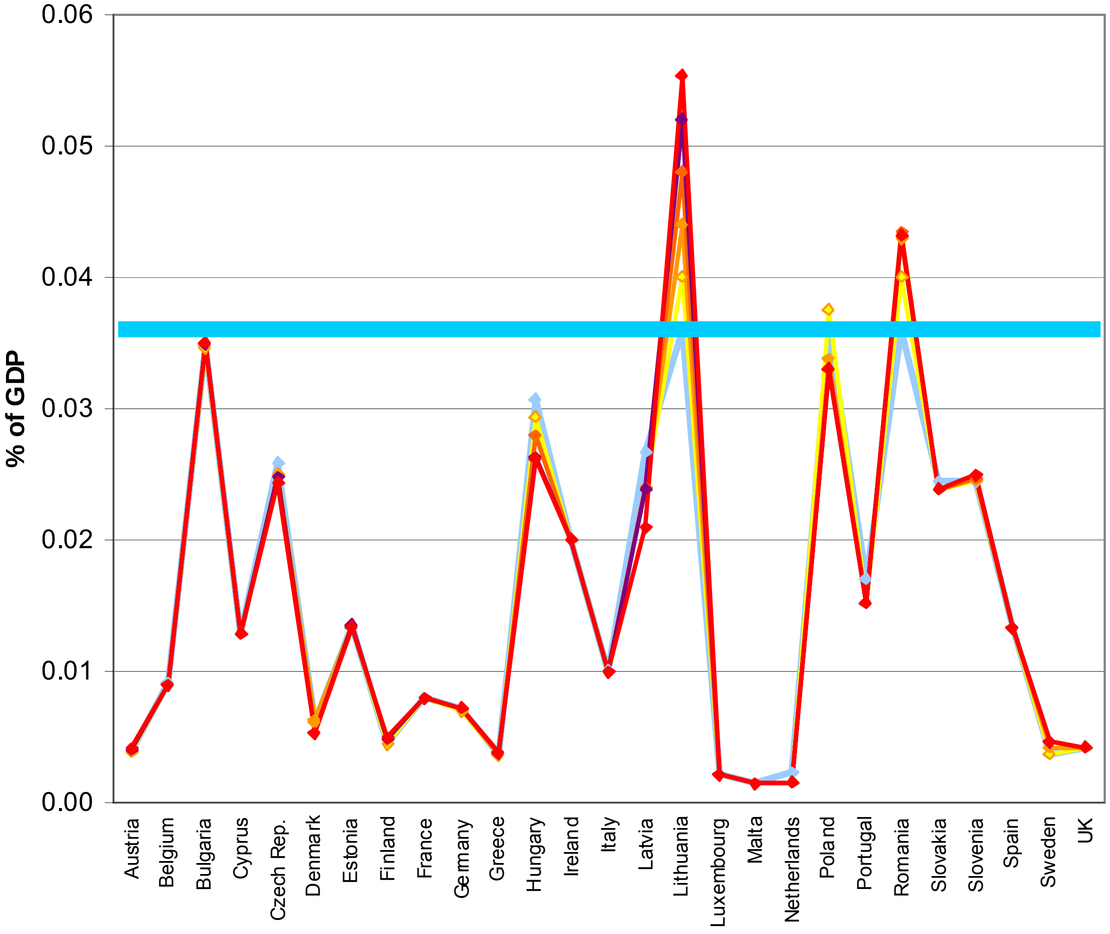
Costs as % of GDP per Member State



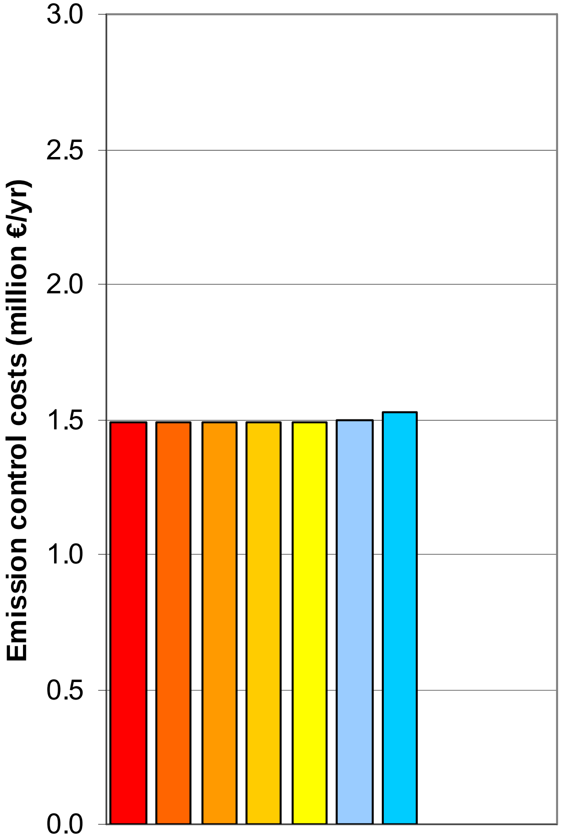
Trade-off between efficiency and equity

Increase in total costs if GDP-related costs in each MS limited

Costs as % of GDP per Member State



Costs for EU-27



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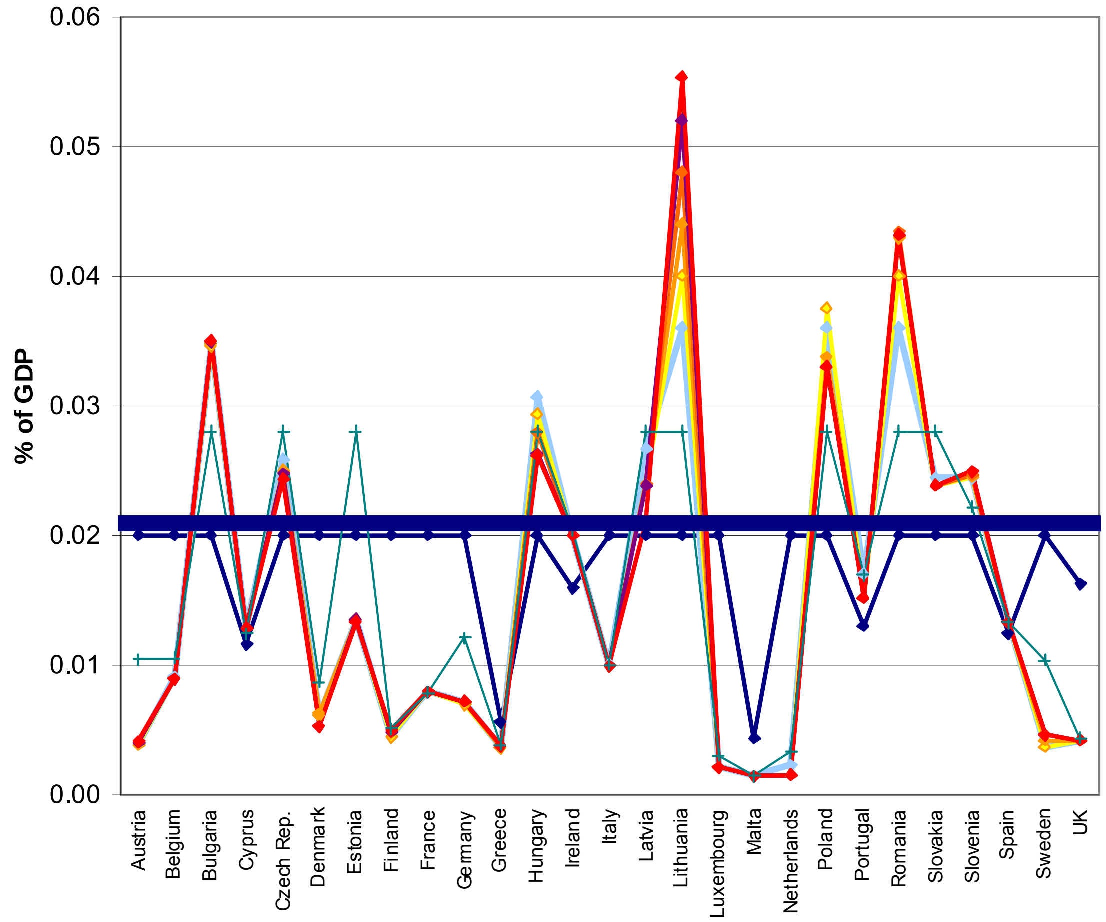
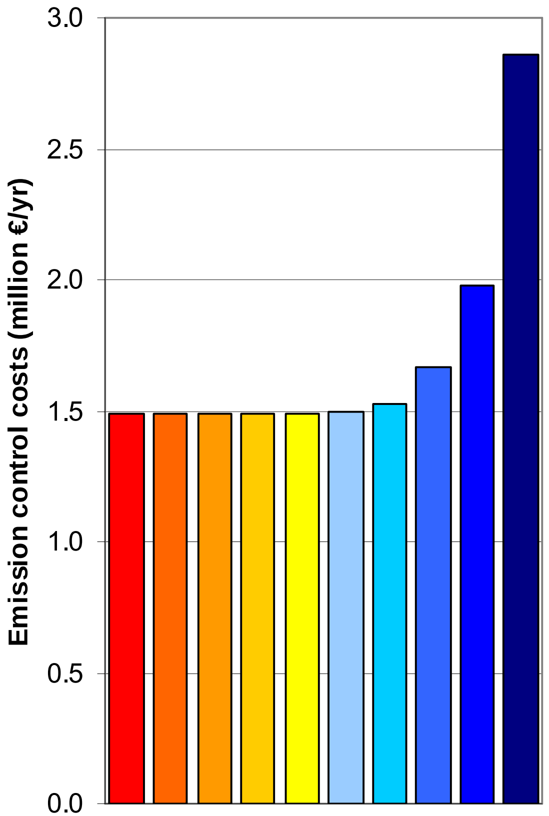


Costs for EU-27



Integrating over different policy areas:

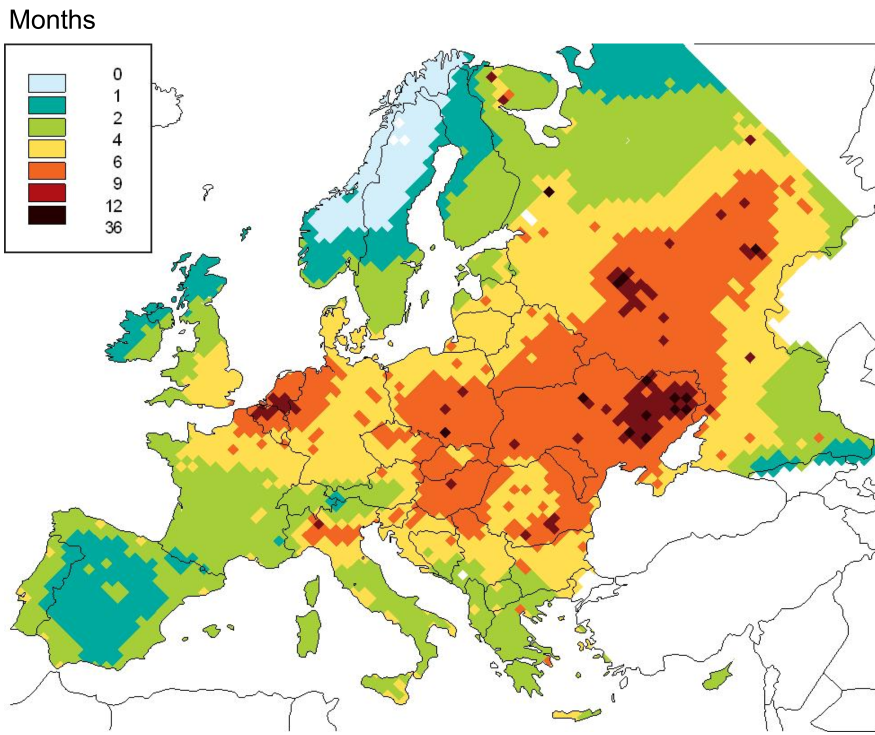
GAINS: A model to harvest synergies by integrating multiple pollutants and their multiple effects

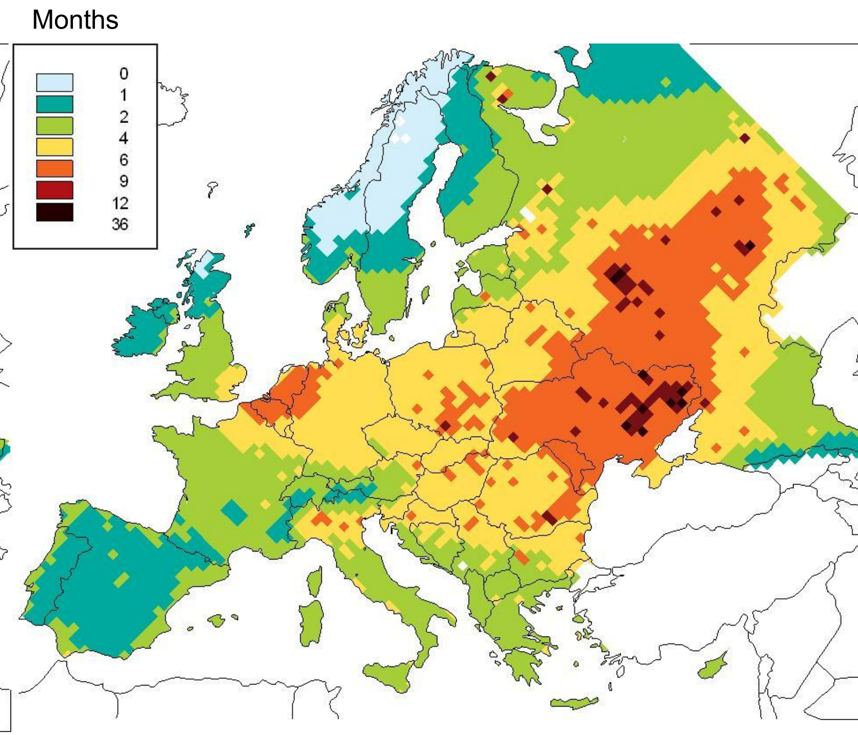
IIASA

Impacts	Emissions and control measures for air pollutants: PM	SO_2	NO_x	VOC	NH_3	and greenhouse gases: CO_2	CH_4	N_2O	HFCs PFCs SF_6
Health impacts: from fine particulate matter	√	√	√	(√)	√				
from ground-level ozone			√	√			(√)		
Vegetation damage: Ozone (agricultural crops)			√	√			(√)		
Acidification (forests)		√	√		√				
Eutrophication (biodiversity)			√		√				
Radiative forcing: - from direct greenhouse gases						√	√	√	√
- via aerosols and ozone	(√)	(√)	(√)	(√)	(√)		(√)		

Estimated loss in statistical life expectancy due to the exposure to anthropogenic PM2.5 in 2020

(Source: IIASA's GAINS model)

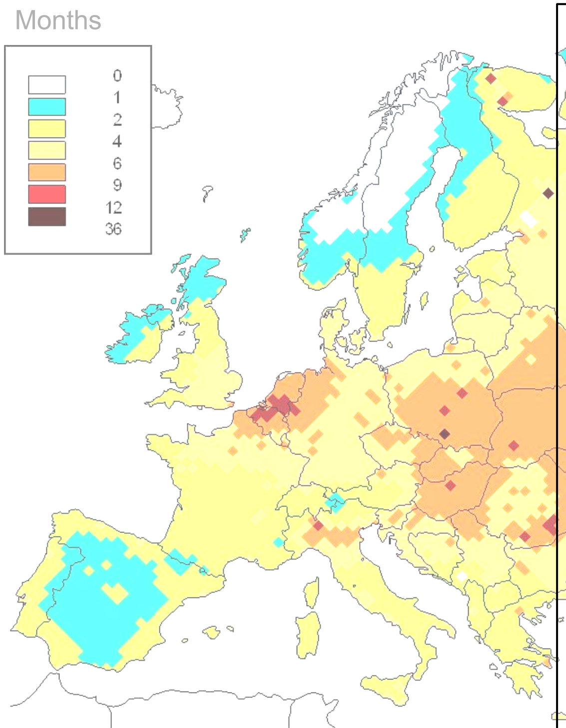


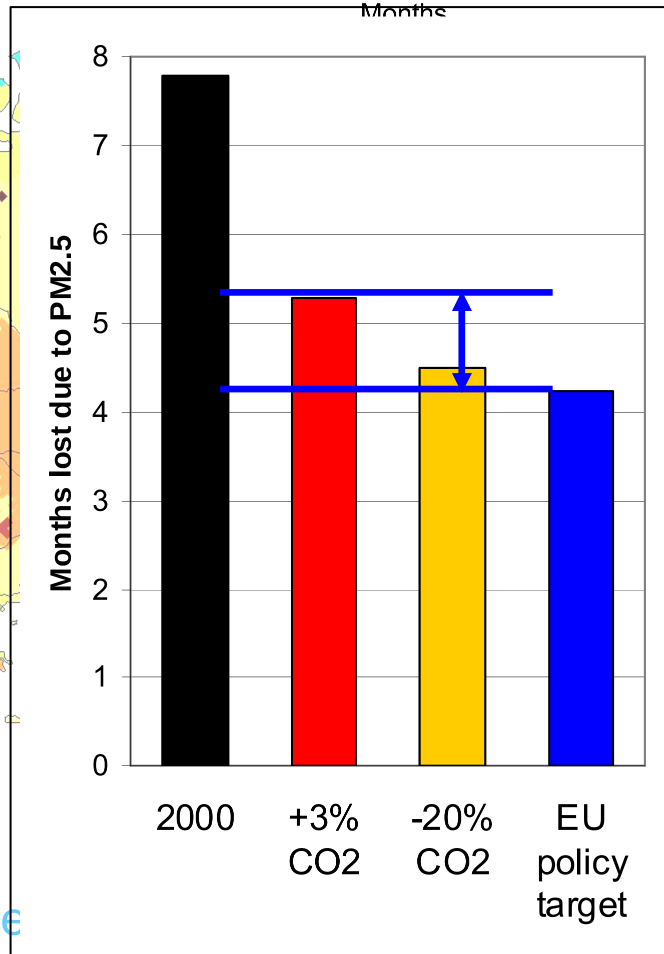


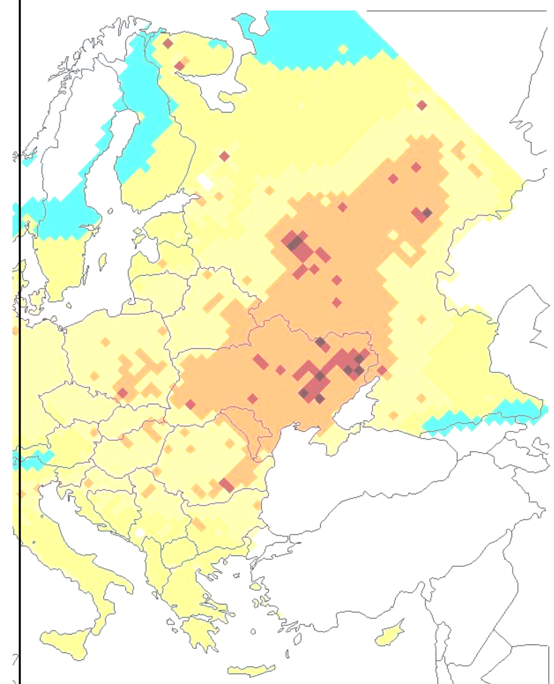
Business-as-usual
National energy projections
(+3% CO_2 in 2020)

Illustrative energy projections
meeting the EU climate target
(-20% CO_2 in 2020)

GHG mitigation strategies have substantial co-benefits on human health via lower air pollution



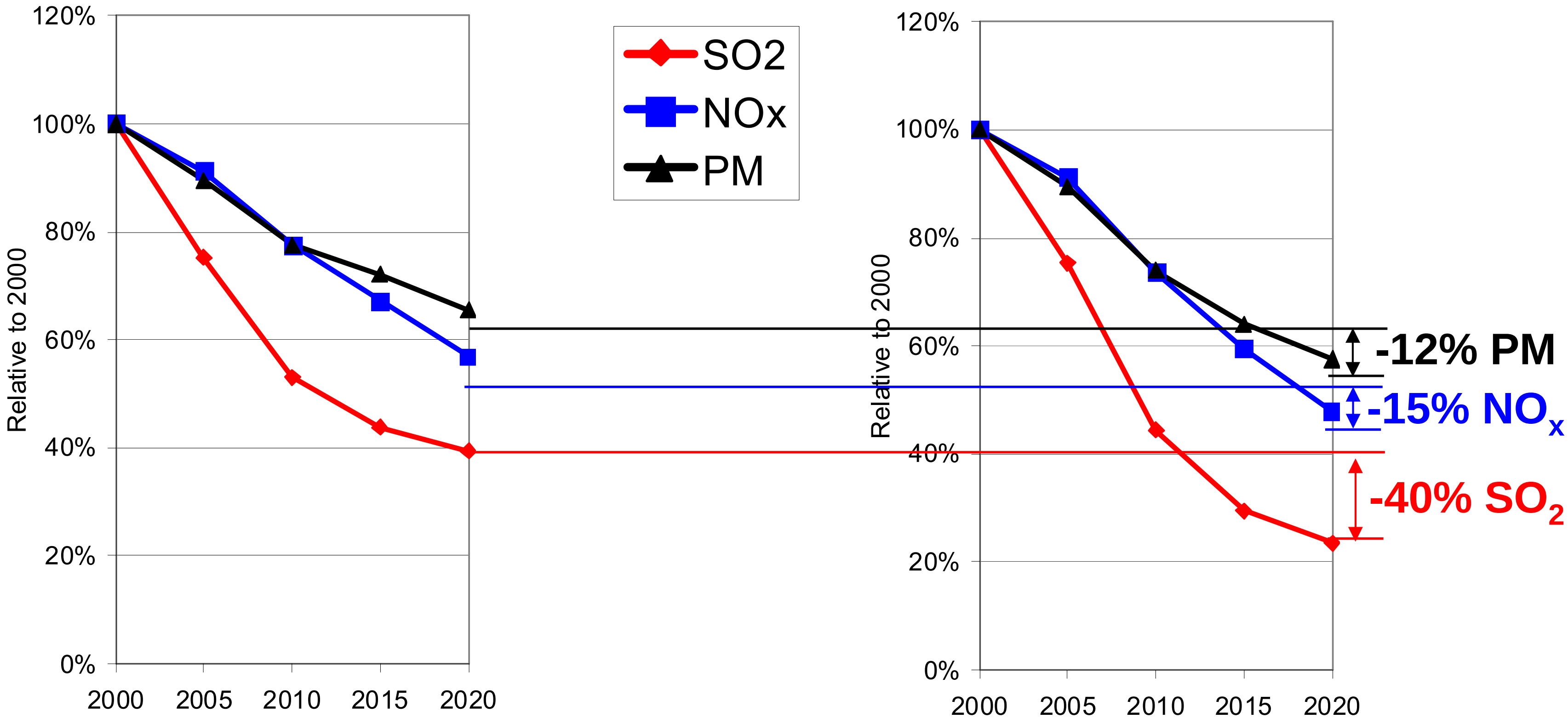




Business-as-usual
national energy proje
(+3% CO_2 in 2020)

ES energy scenario
h climate measures
(-20% CO_2 in 2020)

Air pollution emissions in the EU-27

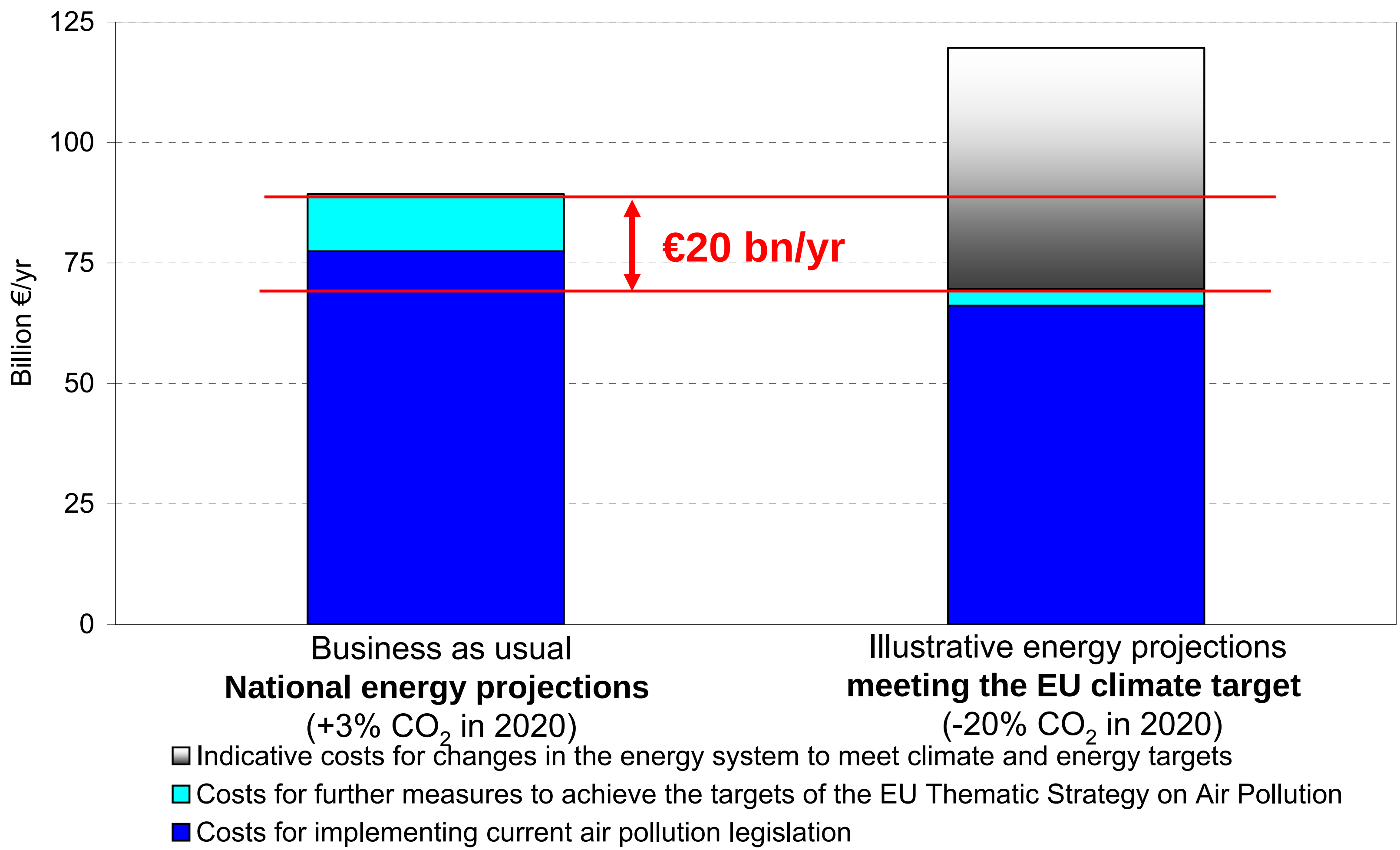


Business-as-usual
national energy projections
(+3% CO_2 in 2020)

PRIMES energy scenario
with climate measures
(-20% CO_2 in 2020)

Emission control costs to meet the EU air quality and climate targets

EU-27, 2020 (Source: IIASA's GAINS model)



GAINS - *Asia*

Greenhouse gas and **A**ir pollution
INteractions and **S**ynergies

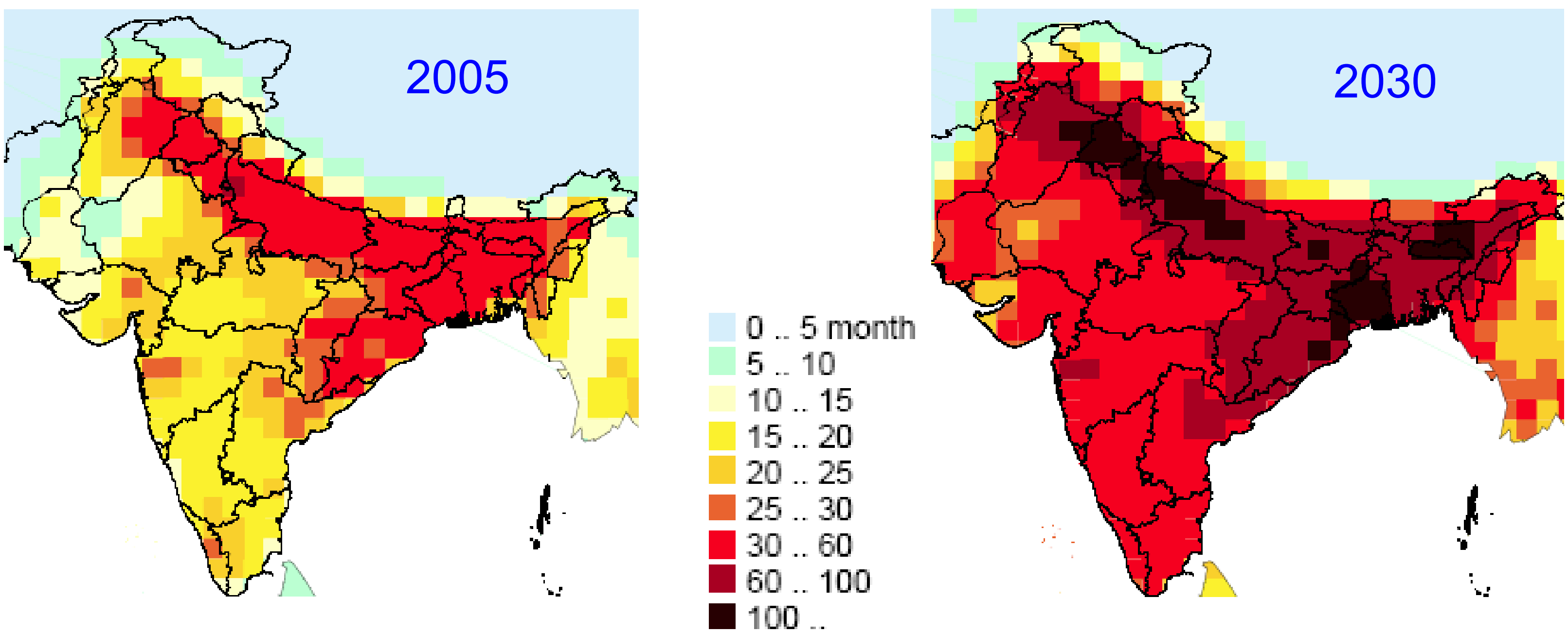
GAINS-*Asia*; a collaborative effort

- International Institute for Applied Systems Analysis (IIASA)
  Laxenburg, Austria
- Energy Research Institute (ERI)
  Beijing, China
- The Energy and Resources Institute (TERI)
  Delhi, India
- Institute for Environment and Sustainability of the Joint Research Centre of the European Union (JRC-IES)
  Ispra, Italy

The research was funded by the sixth framework program (FP6) of the European Union

Air quality problems are expected to intensify
unless additional air pollution controls are implemented

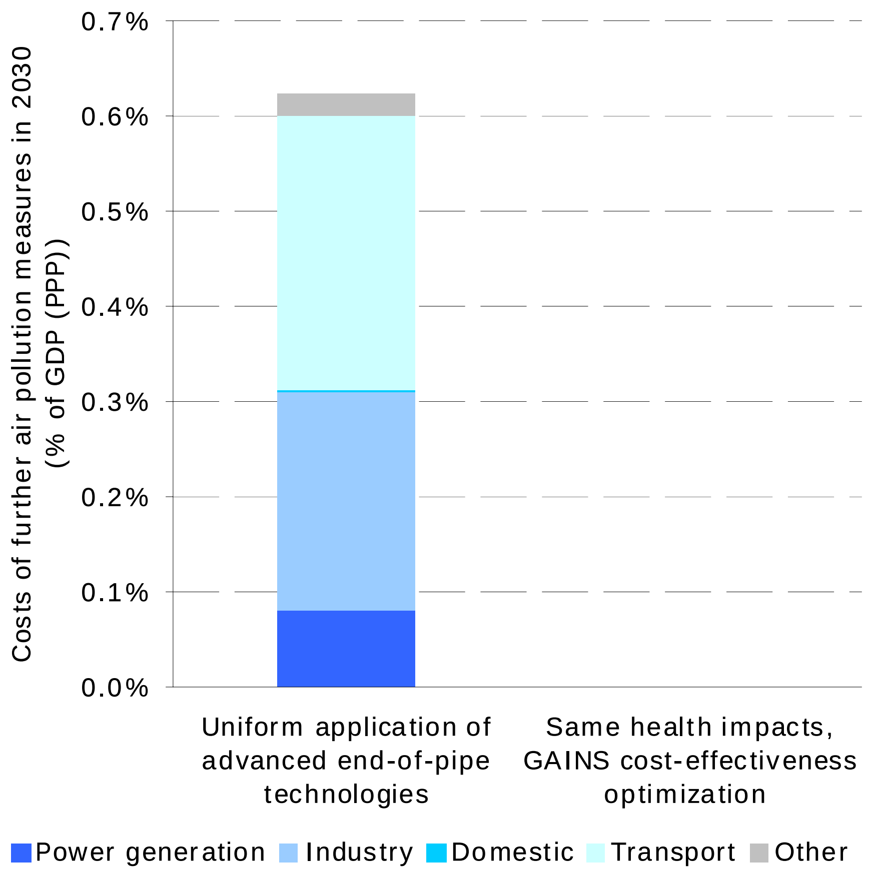
Loss in statistical life expectancy
attributable to outdoor exposure of PM2.5 (GAINS estimates)



The GAINS cost-effectiveness approach can reduce costs for improving air quality by up to 80%

- Full application of advanced emission control technologies can reduce health impacts in China by 43% in 2030

Emission control costs for reducing PM health impacts in China by 43%

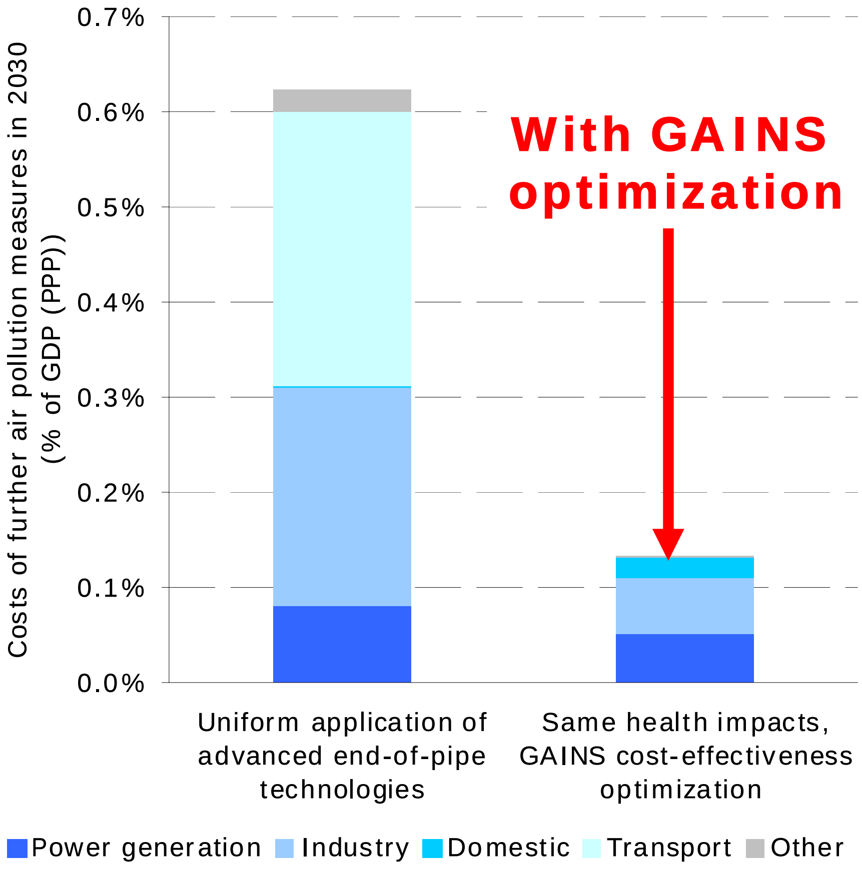


The GAINS cost-effectiveness approach can reduce costs for improving air quality by up to 80%

- Full application of advanced emission control technologies can reduce health impacts in China by 43% in 2030

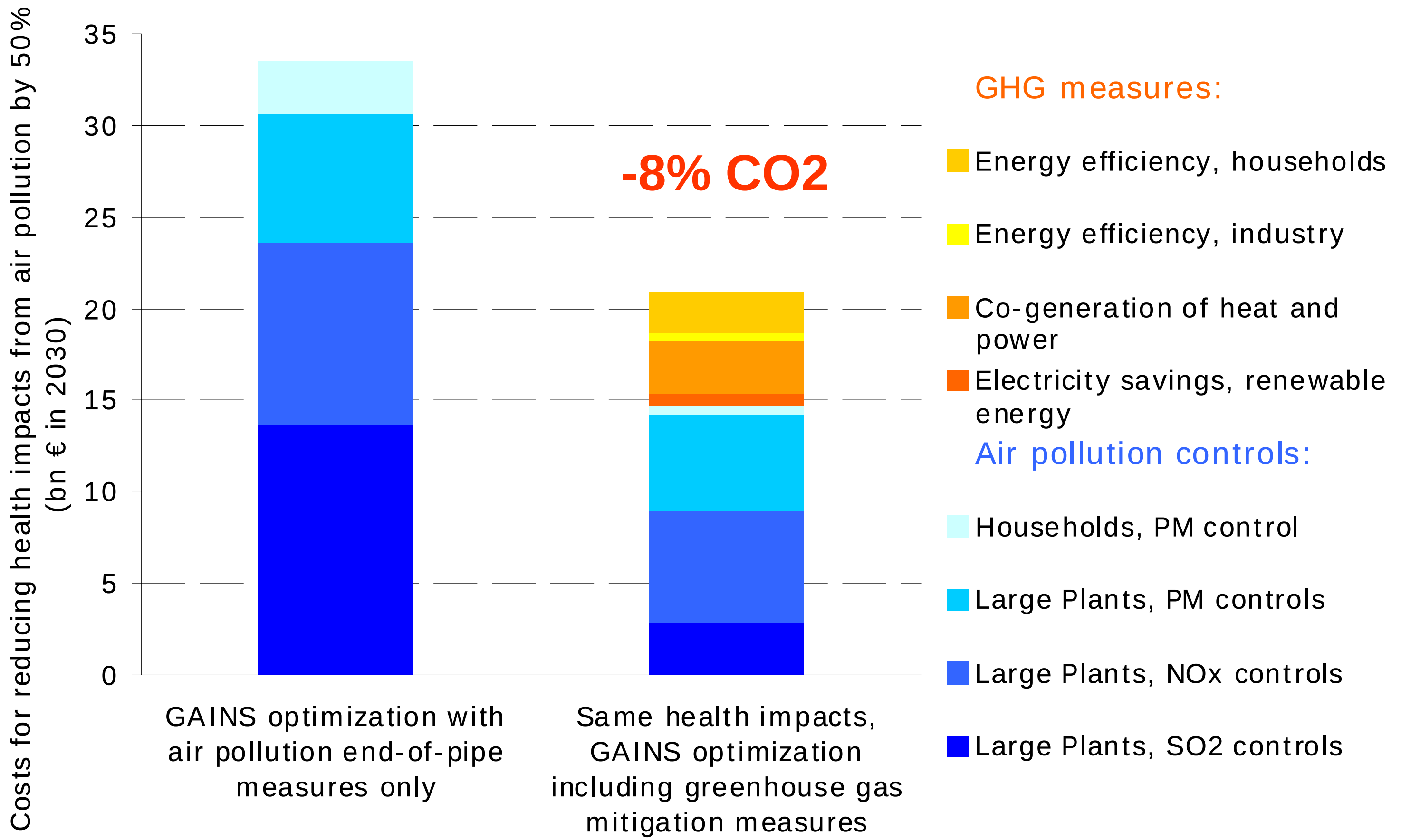
- The GAINS optimization can identify the most cost-effective portfolio of measures – these achieve the same health improvements at 20% of the costs

Emission control costs for reducing PM health impacts in China by 43%



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

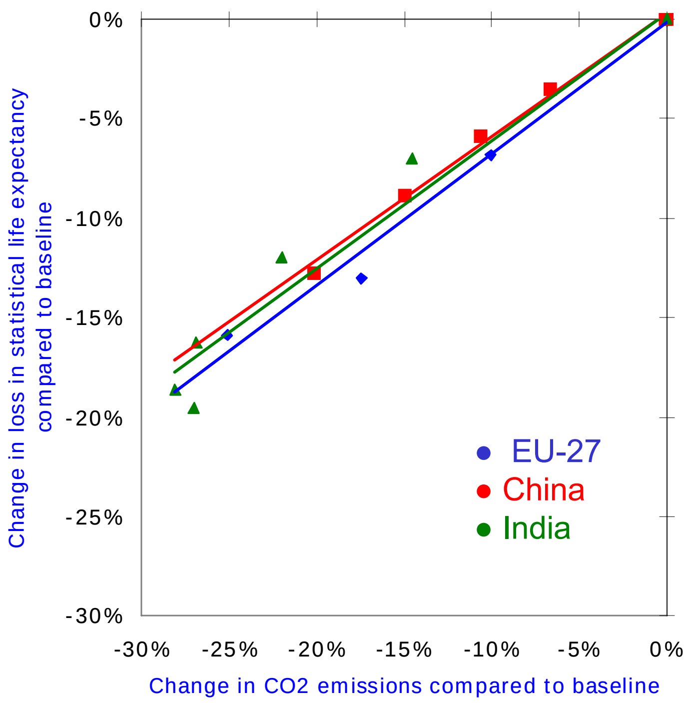
Emission control costs for reducing PM health impacts in China by 50%



Low carbon strategies have significant co-benefits - in Europe and in Asia

- Low CO_2 strategies result in
  - less SO_2, NO_x and PM emissions,
  - lower damage to health and vegetation from reduced air pollution,
  - cost savings for air pollution control equipment, compensating for up to 40% of GHG mitigation costs.

CO_2 emissions vs. health impacts (YOLLs)



Conclusions

Conclusions

- An integrated approach is required to develop effective air quality management strategies that consider the many dimensions of air pollution and economic development. The LRTAP Convention is a good example for practical implementation.
- Looking beyond a narrow air pollution perspective reveals potential synergies with other policy areas, such as climate change. This facilitates increased economic efficiency.
- Tools are available that help designing policies that maximize co-benefits. GAINS has been implemented for Europe, China, India, and is ready for applications to other countries.

Models help to separate **policy** and technical questions

Decide ambition level - environmental objectives

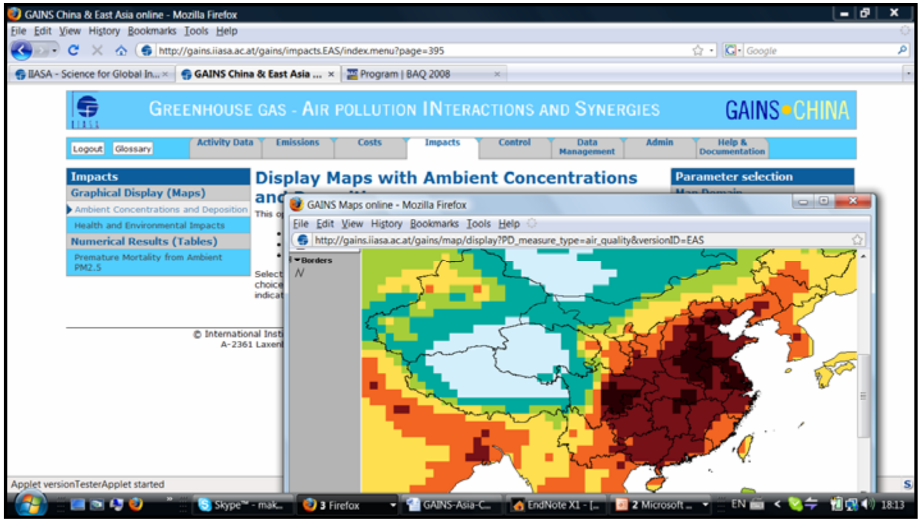
Value the importance of uncertainties/risk

Identify cost-effective and robust measures:

– Balance controls over different countries, sectors and pollutants
– Regional differences in Europe
– Side-effects of present policies
– Maximize synergism with other air quality problems
– Search for robust strategies

The GAINS model is freely accessible on the Internet: http://gains.iiasa.ac.at

- Access to on-line versions
  - China
  - India
  - Europe



- Policy reports, user tutorials, model documentation, etc.

- Implementations for other countries are possible with limited efforts

  – let’s talk!

Mitigation Efforts Calculator

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GAINS • MITIGATION EFFORTS CALCULATOR

Greenhouse gas - Air pollution Interactions and Synergies
International Institute for Applied Systems Analysis

Scenario: IEA 2008 | Year: 2020 | Interest rate: 20% | Refresh | Export | Logout

Party	Base year	Emission range in 2020		Emission target			Mitigation Cost			
	1990	Baseline	max. mitig.	Total	Change to	Per capita	Carbon price	Total costs	% of GDP	Per capita
	Mt CO2eq	Mt CO2eq	Mt CO2eq	Mt CO2eq	2005	tCO2eq/ cap	€/t CO2eq	bln €/yr	%	€/cap/yr
Target for each Party					-20% %				%	
Australia	416	611	407	424	-20.0 %	18.1	20000	19.27	2.81 %	822.9
Canada	592	796	563	588	-20.0 %	16.1	250	7.44	0.58 %	203.3
EU 27*	5568	5565	4406	4406	-14.4 %	8.9	20000	441.98	2.82 %	890.4
Japan	1272	1315	1007	1086	-20.0 %	8.7	20000	19.98	0.29 %	160.3
New Zealand	62	85	60	62	-20.0 %	13.4	20000	2.28	2.49 %	494.5
Norway	50	59	49	49	-9.0 %	10.3	20000	4.51	1.15 %	947.4
Russian Federation	3326	2831	1925	1925	-9.4 %	13.7	20000	152.15	11.79 %	1081.4
Switzerland	53	60	42	43	-20.0 %	5.9	20000	2.77	0.76 %	382.7
Ukraine	922	442	268	341	-20.0 %	8.2	80	3.63	2.58 %	87.4
United States of America	6135	7152	5105	5685	-20.0 %	16.6	250	95.11	0.55 %	277.6
Total for Annex I	18396	18916	13832	14608	-17.0 %	12.0		749.12	1.71 %	612.8