Structured, Science-based Environmental Policy Making: The Case of Air Pollution in Europe

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International Institute for Applied Systems Analysis (IIASA)

- International and independent research organization
- Located 20 km south of Vienna in Austria
- Founded during the Cold War (1972) on neutral soil
- 24 Members (typically Nat'l Academies of Sciences):
  - USA, China, India, Brazil, Russia, UK, Germany, Indonesia, South Africa, Japan, Australia, Pakistan, + 12
- Policy-oriented systems analysis of:
  - Climate and Energy
  - Food and Water
  - Poverty and Equity
- 250 international researchers

Suppose we could extend your life expectancy by one month.

How much would you be willing to pay for this, every year from now until the end of your life?

The new EU directive on air pollution (adopted on 7 Oct 2015 by the EU parliament) can achieve this at **$8/yr per person**.

Why environmental policy?

(and how science can help crafting it)

Two theories of intervention:

- To correct ‚market failures' (Public interest theory)
- Avoid intransparent and ‚irrational' decision making influenced by particular interest groups (Public choice theory)

Human health impacts

EU in 2005
Loss in statistical life expectancy due to **PM2.5** pollution:

8.4 months

(355 million life years lost)

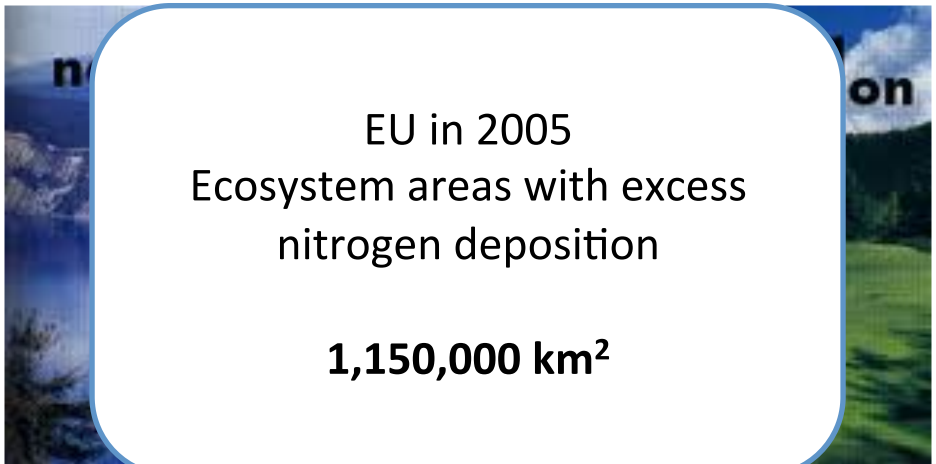
EU in 2005
Cases of premature deaths attributable to ground-level **ozone**

26,400 cases

Acidification

EU in 2005
Forest area with acid deposition above their critical loads
12.5%

Freshwater catchment areas with acid deposition exceeding critical loads for acidification
18,000km^2

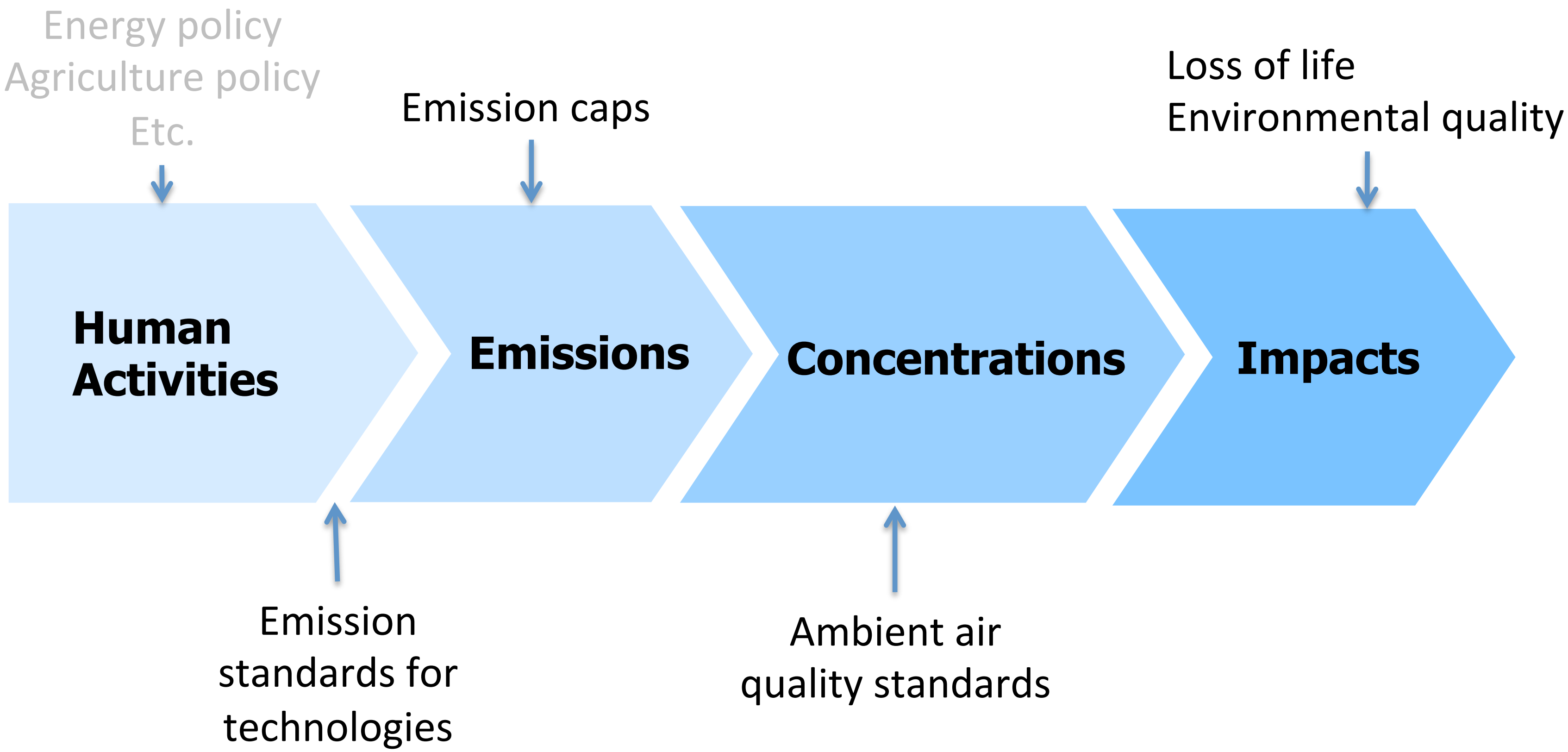


EU in 2005
Ecosystem areas with excess nitrogen deposition

1,150,000 km^2

Eutrophication

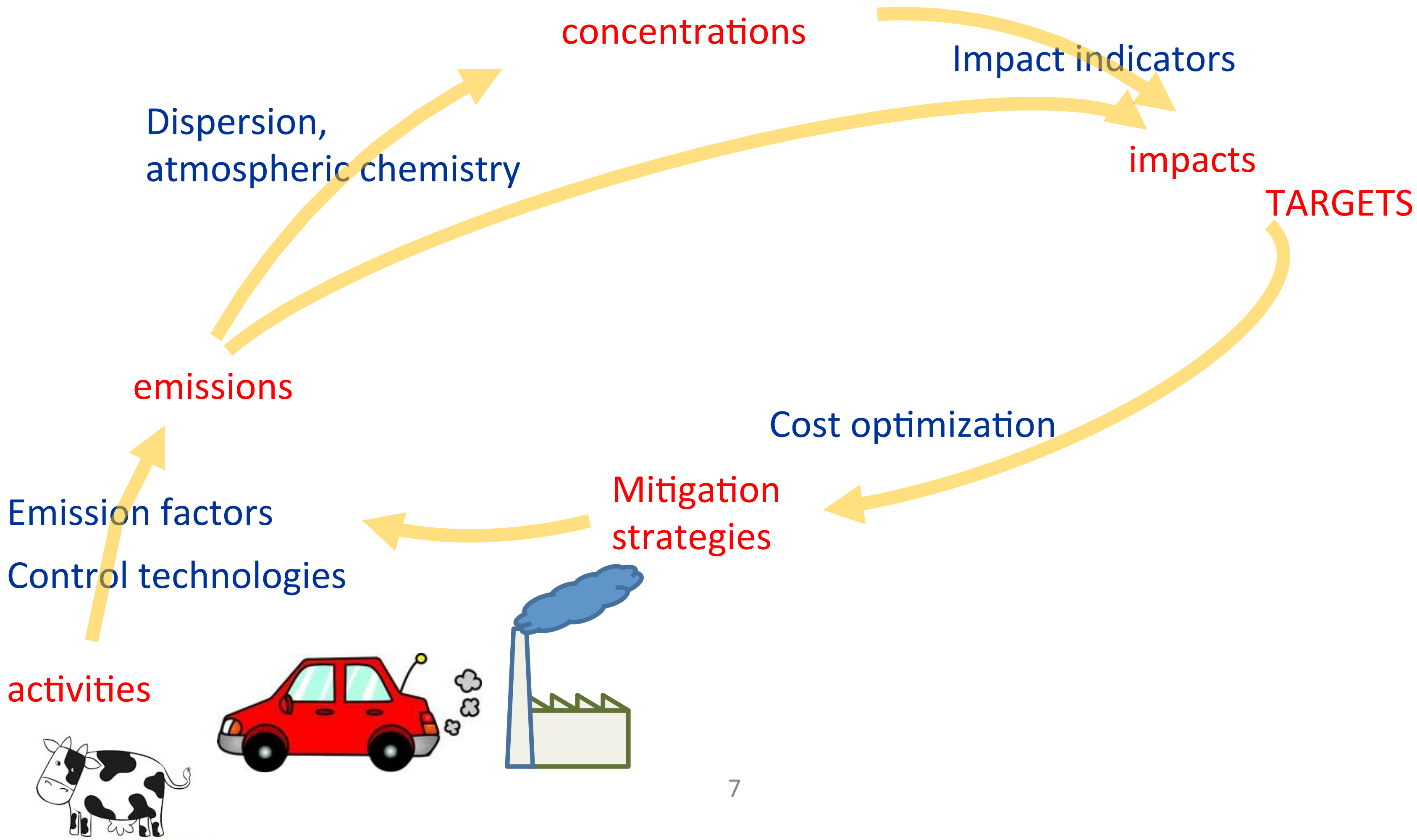
The causal chain: Where policy targets are set



Principles of the GAINS model:

- Multi-pollutant, multi-effect integrated assessment model

Greenhouse gas – Air pollution INteractions and Synergies



GAINS model: some specifications

Emissions module

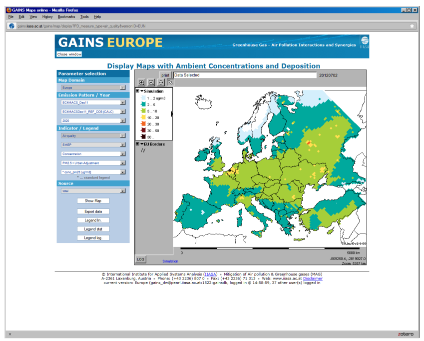
- 43 countries in Europe
- 10 pollutants + 6 GHGs
- 1990-2050 – 5yr-steps
- >1,000 emission source types per country
- 3-8 mitigation options per source
- Technology costs
- Technology constraints

Impacts

- Impacts:
  - Mortality PM2.5
  - Mortality ozone
  - Eutrophication
  - Acidification
- Spatial resolution: 28 km x 28 km

Freely accessible web interface:

http://gains.iiasa.ac.at/models/index.html



Fine Particulate Matter

< 2.5 micrometer diameter (PM2.5)

Primary particles

- Directly emitted from
  - Fly ash (coal burning)
  - Incomplete combustion
  - Industrial processes
  - Dust
  - Sea salt
  - Sand
  - Re-suspension

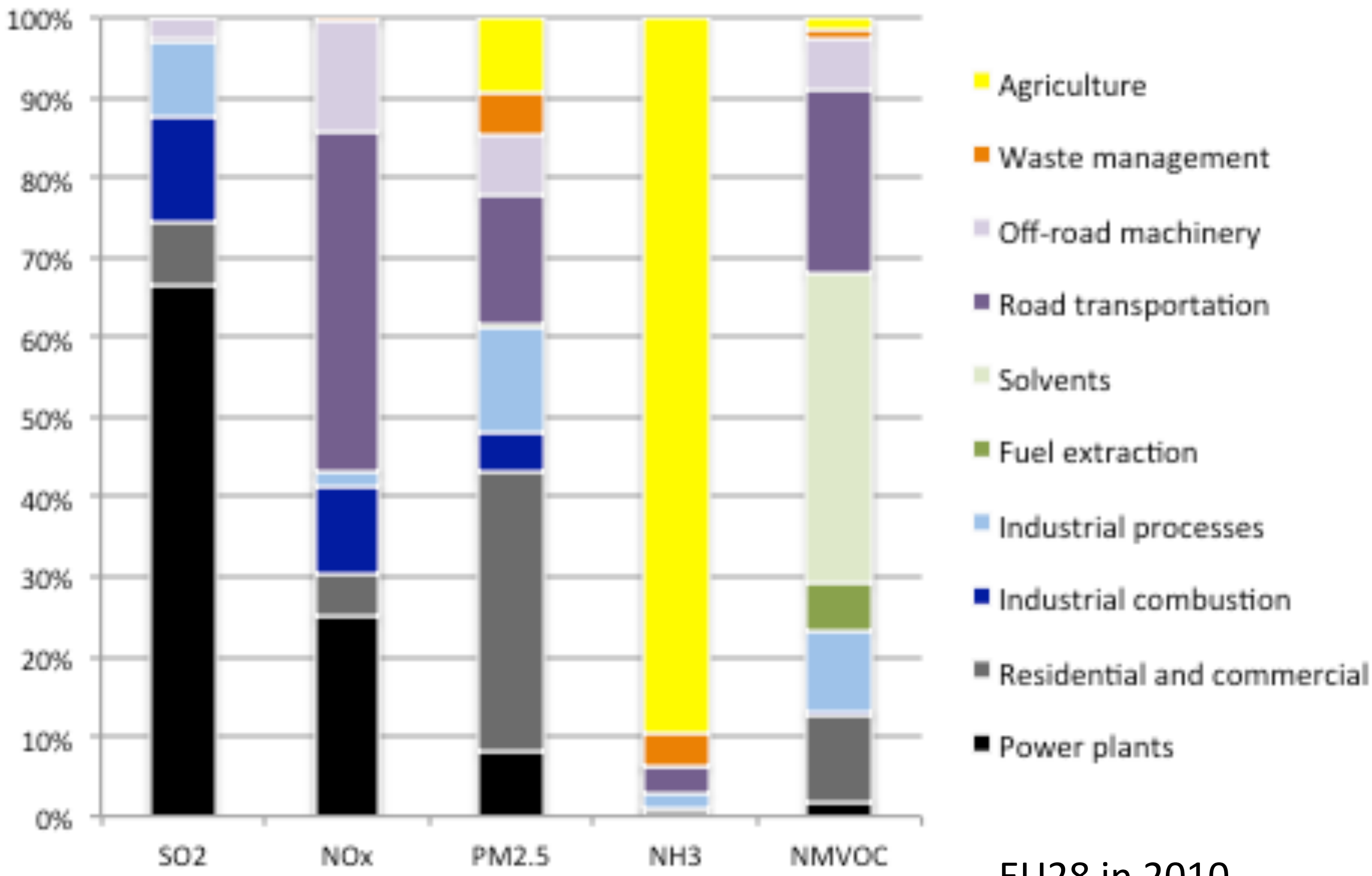
Secondary matter

- Formation in chemical and physical processes from emissions of:
  - Primary particles
  - Sulfur dioxide (SO_2)
  - Nitrous Oxides (NOx)
  - Ammonia (NH_3)
  - Volatile organics (VOC)

The Matrix

	PM (BC, OC)	SO_2	NO_x	VOC	NH_3
Health impacts:					
PM (Loss in life expectancy)	√	√	√	√	√
O_3 (Premature mortality)			√	√	
Vegetation damage:					
O_3 (AOT40/fluxes)			√	√	
Acidification (Excess of critical loads)		√	√		√
Eutrophication (Excess of critical loads)			√		√

Who is responsible for emissions? (multiple stakeholders)



EU28 in 2010

The 7-phase process

1. Bilateral consultations with Member States
2. Assessment of current policies

Assessment of current policies

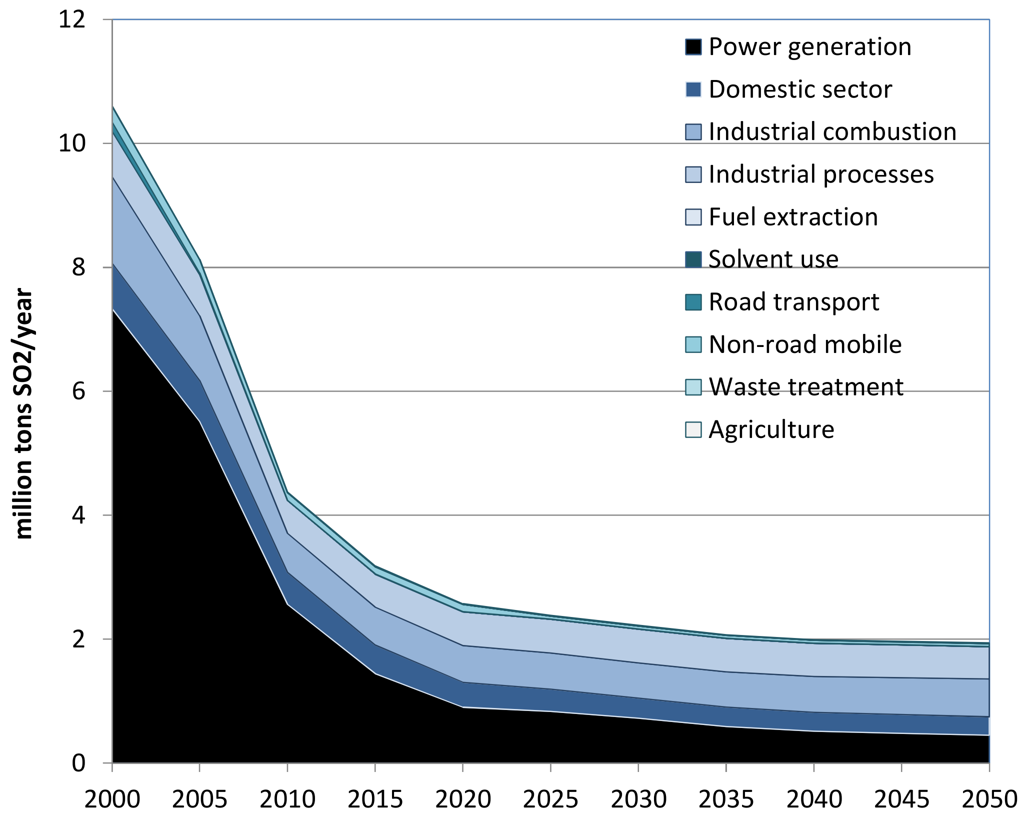


Figure 4.5: SO_2 emissions of the EU-27 by SNAP sector

Assessment of current policies

Emissions

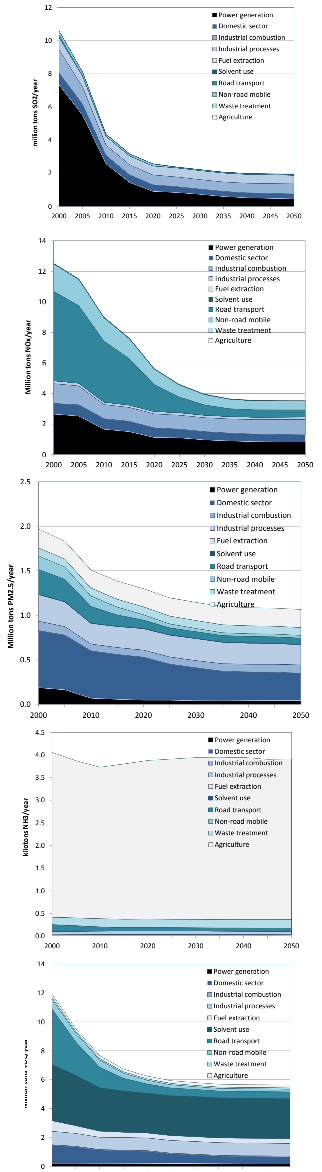
SO_2

NO_x

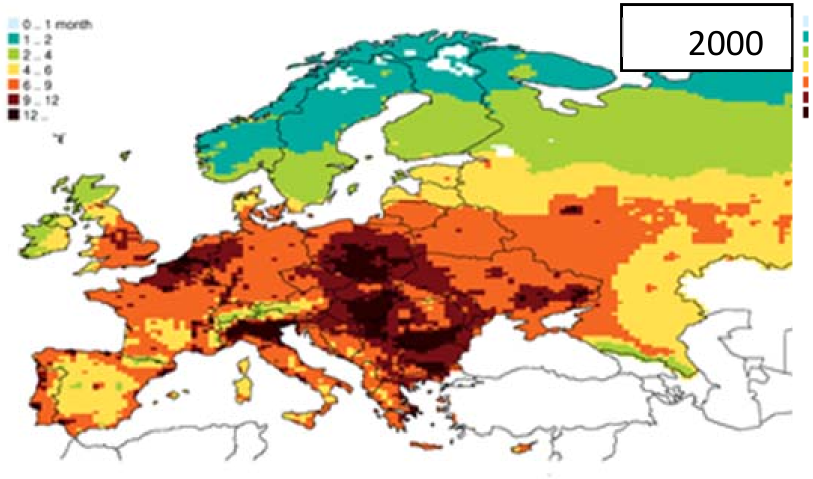
PM2.5

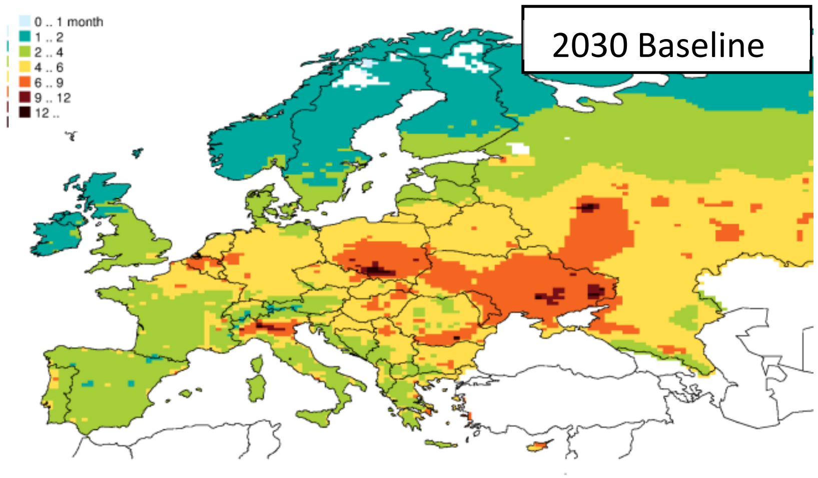
NH_3

VOC



Loss in life expectancy





The 7-phase process

1. Bilateral consultations with Member States
2. Assessment of current policies
3. Assessment of reduction potentials

Scope for reducing, e.g. future PM2.5 emissions

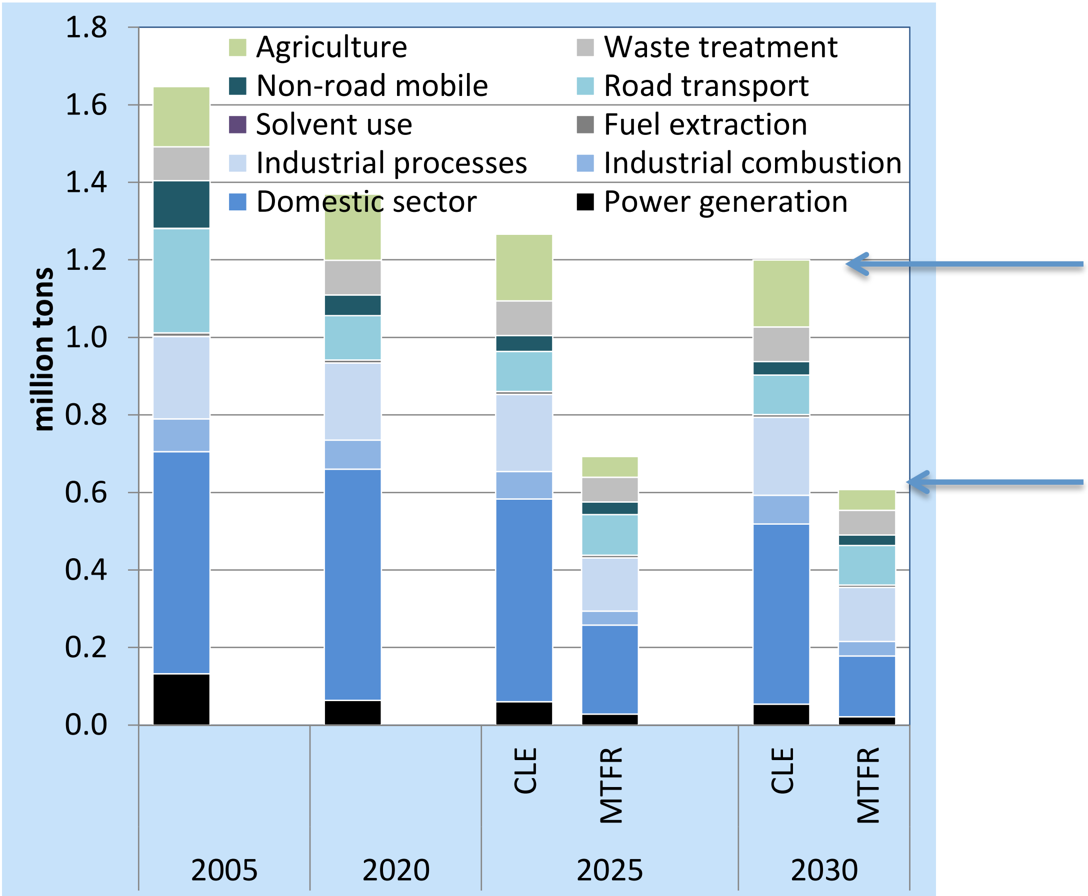


Figure 3.3: PM2.5 emissions of the TSAP 2013 Baseline; Current legislation (CLE) and Maximum Technically Feasible Reductions (MTFR), EU-28

Potential for reducing impacts

Years of Life Lost (YOLL)

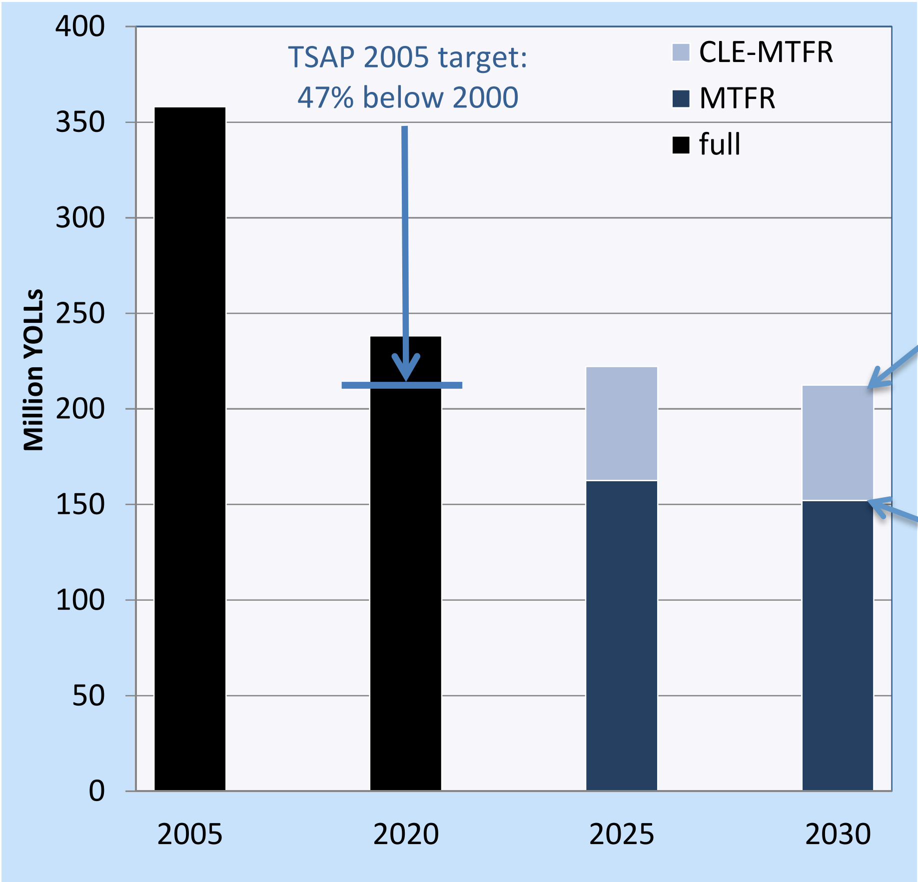


Figure 3.9: Years of life lost (YOLLs) due to exposure to fine particulate matter, EU-28

Current legislation

the „gap“

Maximum technically feasible (MTFR) reduction

„gap closure“

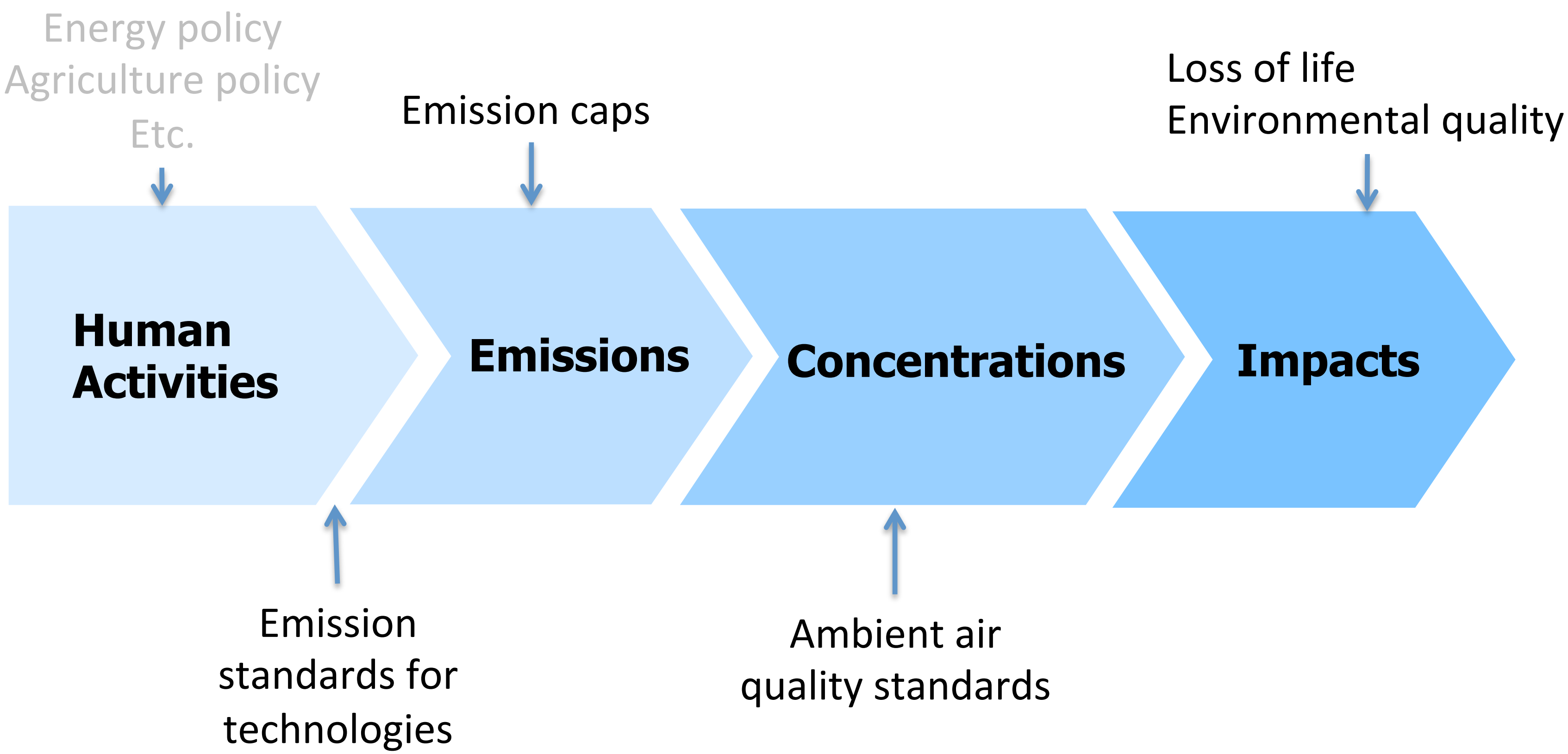
0%

100%

The 7-phase process

1. Bilateral consultations with Member States
2. Assessment of current policies
3. Assessment of reduction potentials
4. Target setting options + ambition levels

Target setting approaches



Choosing a target level:
Marginal costs and marginal benefits

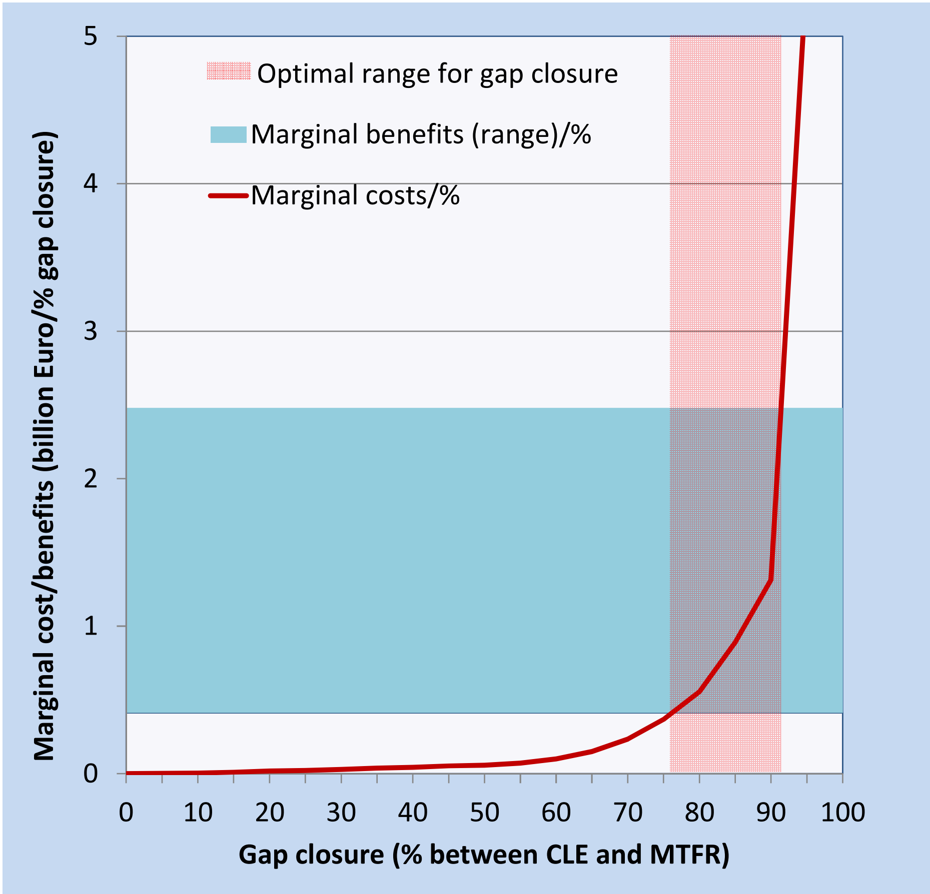


Figure 4.2: Marginal emission control costs and marginal health benefits in 2025

The 7-phase process

1. Bilateral consultations with Member States
2. Assessment of current policies
3. Assessment of reduction potentials
4. Target setting options + ambition levels
5. **Proposal by the Commission**

Key elements of adopted proposal

- 67% gap closure on PM-health indicator in 2030
  - life expectancy -> **+ ~ 1 month**
  - Resulting emission ceilings for 5 pollutants in 28 Member States
- Co-effects on other indicators
  - Avoided 1,000 ozone-related deaths per year
  - 20,000 km^2 forests protected from acidification
  - 140,000 km^2 ecosystems protected from eutrophication
- 3.3 billion Euros/yr
  - 0.021% of GDP in 2030 (0.001%-0.176% across MSs)
  - **$8 per person per year**

The 7-phase process

1. Bilateral consultations with Member States
2. Assessment of current policies
3. Assessment of reduction potentials
4. Target setting options + ambition levels
5. **Proposal by the Commission**
6. Bilateral consultations + sensitivity studies
7. Additional analyses for EU parliament

Adoption by EU parliament and Council of Ministers

Structured, science-based decision making

- A multi-stage (multi-year) process
  - Multi-way iterative communication
- Integrated assessment methods
  - Interdisciplinary (multidisciplinary + integration)
  - Independent scientific institution(s)
  - Open source data and information
  - Identification of win-win strategies
- Clear communication of principles:
  - cost-effectiveness and (cost < benefits)
  - equity
- Clear distinction between:
  - Peer-reviewed evidence-focussed science
  - Expert judgements
  - Value judgements by stakeholders

Conclusions

Structured, science-based decision making

- allows a systematic assessment of different options in collective action problems
- can result in cost-effective environmental policy
- can enhance trust that new regulation is rational, efficient, and overall beneficial

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Example:
cost-optimal distribution of PM2.5 reduction measures

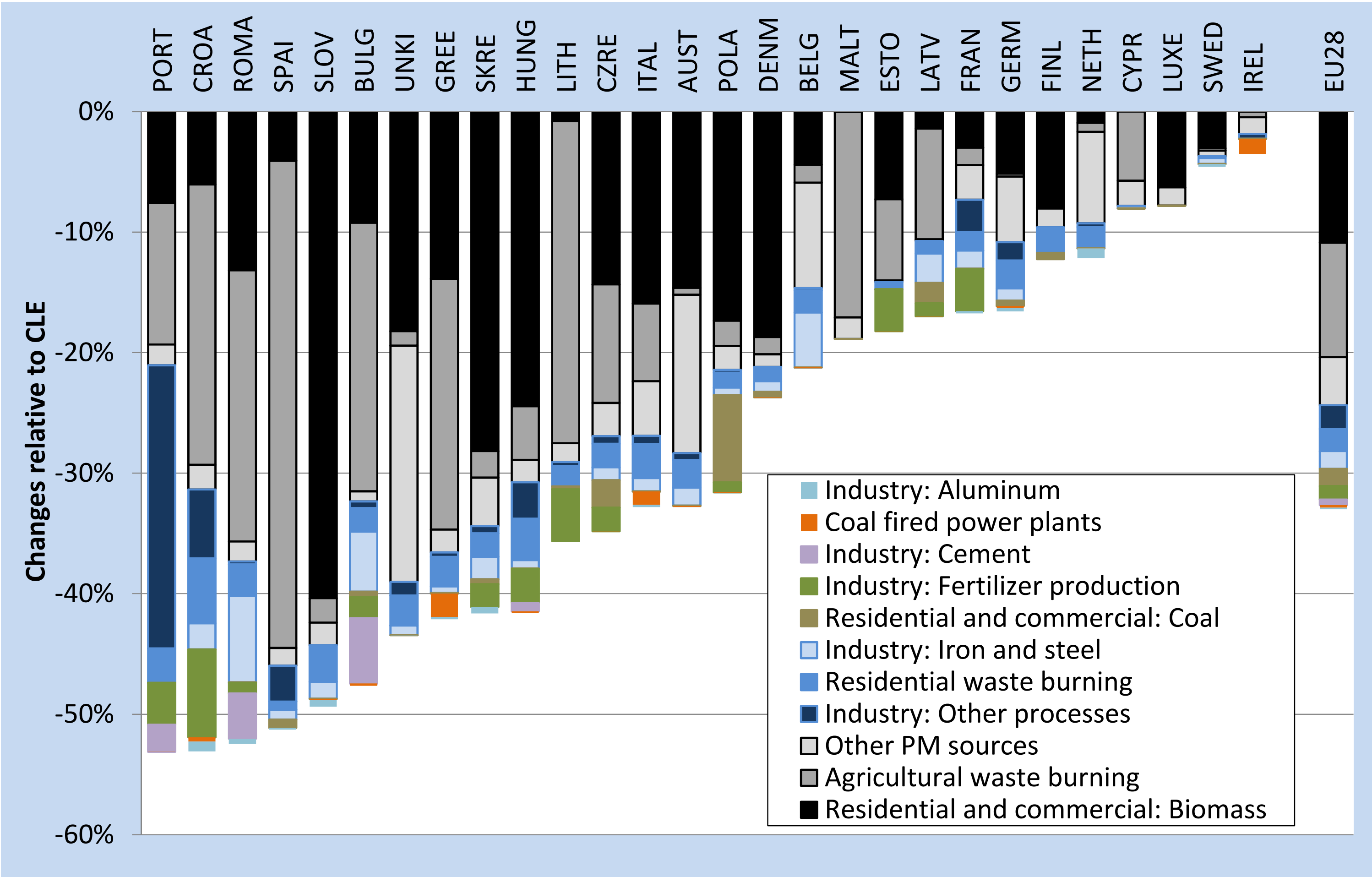

Figure 4.7: Further reductions of PM2.5 emissions (beyond the baseline) of the B7 scenario, relative to baseline emissions