PBL Netherlands Environmental Assessment Agency

# Flexibility in air policies

## Quantitative analysis of welfare gains

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# Flexibility in air pollution policies

Why?

- emission ceilings => improvement air quality
- reflect assessment of
  - cost-effectiveness
  - cost and benefits (implicitly/explicitly)
- given assumptions about:
  - future economic development (baseline)
  - abatement cost

But:

- many uncertainties
- targets for improvement not at any cost

# Key question

- How can we set proper air quality targets such that, also in a future that is different from what we expected, the improvement is achieved in a cost-effective way?

- Flexibility
  - between pollutants
  - between countries

- How?
  - country and pollutant specific exchange factors
  - contribution per unit of emission to **total** human health impact and ecosystem effects in **Europe**

# Methodology

- source-receptor matrices EMEP

- Health impacts
  - contribution to PM2.5 and $O_3$ (somo35)
  - added up using relative contribution (0.6 vs. 0.03)
  - population weighted sum

- Ecosystem effects
  - acidification and eutrophication
  - added up according to rate sensitive areas

# Exchange factors for impact on human health

| | $SO_2$ | $NO_x$ | PM2.5 | $NH_3$ |
|---|---|---|---|---|
| Germany | 1.00 | 0.50 | 3.29 | 1.18 |
| France | 0.75 | 0.43 | 2.33 | 0.59 |
| Benelux | 0.90 | 0.26 | 4.25 | 1.46 |
| UK & Ireland | 0.52 | 0.15 | 1.87 | 0.63 |
| Mediterranean countries | 0.42 | 0.36 | 1.77 | 0.80 |
| Spain & Portugal | 0.45 | 0.15 | 1.28 | 0.31 |
| Scandinavia & Baltic States | 0.21 | 0.12 | 0.58 | 0.30 |
| Poland | 0.57 | 0.21 | 1.73 | 0.85 |
| Bulgaria & Romania | 0.39 | 0.33 | 1.06 | 0.57 |
| Austria, Czech Rep., Hungary, Slovakia, Slovenia, Switzerland | 0.78 | 0.50 | 2.03 | 1.19 |
| Norway & Iceland | 0.14 | 0.12 | 0.39 | 0.11 |

# Exchange factors for ecosystem effects

| | $SO_2$ | $NO_x$ | $NH_3$ |
|---|---|---|---|
| Germany | 0.48 | 1.00 | 3.01 |
| France | 0.26 | 0.93 | 2.74 |
| Benelux | 0.59 | 0.99 | 3.30 |
| UK & Ireland | 0.41 | 0.83 | 2.15 |
| Mediterranean countries | 0.06 | 0.77 | 2.01 |
| Spain & Portugal | 0.10 | 0.80 | 2.13 |
| Scandinavia & Baltic States | 0.20 | 0.63 | 2.05 |
| Poland | 0.52 | 0.99 | 3.17 |
| Bulgaria & Romania | 0.08 | 0.77 | 2.08 |
| Austria, Czech Rep., Hungary, Slovakia, Slovenia, Switzerland | 0.29 | 0.94 | 2.55 |
| Norway & Iceland | 0.24 | 0.51 | 0.77 |

# Quantitative analysis

- WorldScan - computable general equilibrium model
  - macro-economic impact of policies
    - › demand shifts
    - › changing production structure
    - › location of economic activities
- Implementation
  - 23 regions (15 within Europe)
  - $SO_2$, $NO_x$, $NH_3$, PM2.5, GHGs
  - Climate and air policies cost-effective combination of:
    - › fuel switch, energy saving, changes in demand
    - › end-of-pipe abatement
  - emissions and emission control based on GAINS

# Simulations

- PRIMES baseline 2009
- Air policy targets: emission levels from GAINS optimisation 75% health improvement Europe-wide (CIAM report August 2010)
- flexibility with different weights for health and ecosystem effects

- Climate policy:
  - pessimistic: EU -20%, no climate policy USA, Japan;
  - optimistic ETS trade: EU -30% (-16% domestic), ETS trade with other Annex1 regions

# Results – pessimistic

| | Cost end-of-pipe (bln €/yr) | | Emis. price (€/kg) | | Emissions (1000 kton) | |
|---|---|---|---|---|---|---|
| | no flex | flex | no flex | flex | no flex | flex |
| SO2 | 0.9 | 0.5 | 4.8 | 2.7 | 2.0 | 2.1 |
| NOx | 0.4 | 0.3 | 2.9 | 1.9 | 5.2 | 5.2 |
| NH3 | 0.9 | 0.5 | 9.1 | 5.5 | 3.2 | 3.2 |
| PM2.5 | 0.6 | 0.4 | 8.5 | 5.6 | 0.9 | 0.9 |

# Results – optimistic ETS trade

| | Cost end-of-pipe (bln €/yr) | | Emis. price (€/kg) | | Emissions (1000 kton) | |
|---|---|---|---|---|---|---|
| | no flex | flex | no flex | flex | no flex | flex |
| SO2 | 1.3 | 0.6 | 7.1 | 3.0 | 2.0 | 2.2 |
| NOx | 0.3 | 0.2 | 2.1 | 1.2 | 5.2 | 5.3 |
| NH3 | 0.4 | 0.2 | 6.2 | 3.5 | 3.1 | 3.1 |
| PM2.5 | 0.6 | 0.6 | 8.3 | 7.1 | 0.9 | 0.9 |

# Differences at country level

| | End-of-pipe cost (mln €/yr) | | | | Emissions (kton) | | | |
|---|---|---|---|---|---|---|---|---|
| | SO2 | | NH3 | | SO2 | | NH3 | |
| | no flex | flex | no flex | flex | no flex | flex | no flex | flex |
| Germany | 21 | 13 | 82 | 0 | 306 | 306 | 456 | 489 |
| France | 97 | 20 | 230 | 0 | 150 | 164 | 494 | 566 |
| Mediterr. countries | 138 | 21 | 279 | 80 | 268 | 314 | 350 | 393 |

# Discussion

- Weights health impact vs. ecosystem effects
- Impact of flexibility on air quality and ecosystems **locally**
- Introduce penalty to use efficiency gains to achieve larger quality improvement
- Not (yet) included/further work:
  - impact $O_3$ on vegetation
  - emissions from shipping
  - concentration variation within countries
  - demographic differences within Europe

# Conclusions

Flexibility worth consideration

- efficiency gains
- better prepared for deviations from baseline assumptions (i.e.: economic growth, EOP costs, other environmental/CC policies)

but

- local effects/'border-effects'
- weighing different impacts (ecosystem versus health)
- Implementation (complexity, transaction costs)
- ...