# External costs and policy

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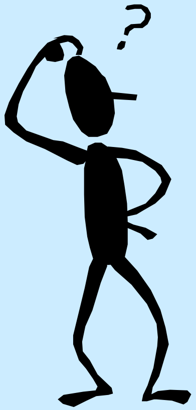


- Mike Holland…
  - is a policy adviser on sustainable development…
  - particularly on air quality, waste and energy issues…
  - using economic and other approaches…
  - for legislators in UK national and local government, the European Commission, UNECE, other national governments, local government and industry.

# Policy applications of externalities

- Types of policy instrument applied in Europe and the USA
- Outline of Cost-effectiveness analysis
- Ways of using external costs in relation to these policy instruments
- Case studies in Europe and Developing Countries
- Question and answer session

# Coverage

- My objective is to give insight into the diversity of uses of external cost estimates.
- Mainly air pollution issues, particularly those linked to the energy sector, the area where externality quantification using impact pathways has been most applied.  This does not mean that the use of externalities is restricted to air quality issues in Europe.

# Where does environmental action in Europe originate?

- UN (FCCC, Montreal Protocol, CITES, etc.)
- UNECE (air pollution, accidents, water quality)
- European Union (all aspects of the environment)
- EU Member States (transposition of EU legislation, own actions)
- Regional Government (England, Scotland, etc., German Länder, etc.)
- Local government (Boroughs, Counties, Cities, etc.)
- Individuals (e.g. energy efficiency), companies, etc.

# Options

LEGISLATION

• Emission ceilings
* Environmental quality standards
* Emission standards
* Production or emission bans
* Energy strategy
* Land use planning
* Clean air zones

GENERAL VOLUNTARY MEASURES

* Management systems
  - ISO 14001
  - EMAS
* Awareness raising measures
  - Best practice programmes
  - Ecolabelling
  - etc

SPECIFIC VOLUNTARY MEASURES

* Energy efficiency
* Switch to cleaner fuels
* Switch to public transport
* 'Ethical' investment funds

Market based mechanisms and other incentives

# Flexible regulation

- Fiscal incentives
  - lead free petrol
  - low sulphur fuels
  - landfill tax
  - energy taxation
  - tradable permits
- EU National Emission Ceilings Directive and UNECE CLRTAP Gothenburg Protocol
  - National total emissions for $SO_2$, NOx, VOCs and $NH_3$

# Why are $SO_2$, NOx, VOCs and $NH_3$ considered together?

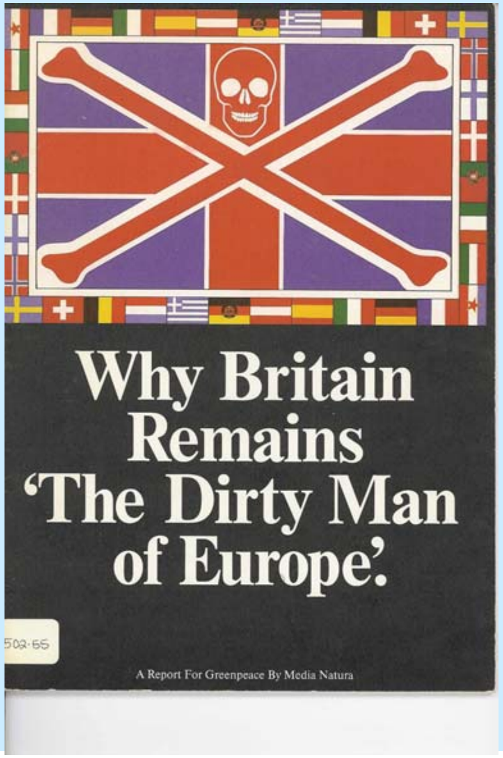
- Acidification:
  - $SO_2$, NOx, $NH_3$
- Eutrophication
  - NOx, $NH_3$
- Ozone
  - NOx, VOCs
- Airborne particles
  - $SO_2$, NOx, $NH_3$

# Methods for compliance with flexible regulation

- Emission Ceilings for $SO_2$
  - Germany: mainly end of pipe measures, reduction of heavy industry in former East Germany
  - UK: re-alignment of energy industries following market liberalisation, followed by switch to lower S coal and some FGD

# Lessons from the UK on meeting emission ceilings

- UK refusal to accept 30% European sulphur abatement targets in the 1980s led to much bad publicity.




NO. 3, JUNE 1996

# Acid News

*Britain's refusal to ratify the 1985 sulphur protocol earned it the epithet of "the dirty man of Europe." In the event however it met the requirements of that protocol with some margin.*

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GREAT BRITAIN

## Break in the clouds

DURING MOST OF the eighties Great Britain was the great hanger-back among nations aiming to curb emissions of air pollutants – refusing both to sign the sulphur protocol under the Convention on Long Range Transboundary Air Pollution in 1985 and scrounging advantages under the EC directive on large combustion plants three years later. Now however HM Inspectorate of Pollution has announced emission limits for power plants that go well beyond the requirements of these international agreements.

Under the EC Directive on Large Combustion Plants of 1988, Great Britain was to reduce its emissions of sulphur dioxide from plants with a capacity of 50 $MW_{th}$ or more by 40 per cent in 1998 and 60 per cent by 2003, from the levels of 1980. By signing a later protocol under the Convention on Long Range Transboundary Air Pollution, in 1994, it undertook to lower the emissions of sulphur by 50 per cent by 2000, 70 per cent by 2005, and 80 per cent by 2010, again from the 1980 baseline. See AN 4/94, pp. 10-11.

Following accession to the EC directive, a national plan was evolved to indicate how compliance was to take place. It was expected that it would require equipment of flue-gas desulphurization to be installed on 12 GW of the country's coal-fired capacity. But the only plants so fitted have been Drax, 4 GW, and Ratcliffe, 2 GW.

The new requirements set by HMIP are traceable to the Environmental Protection Act of 1990, which led to the large power plants being brought under IPC, integrated pollution control. Subsequent discussions between HMIP and the two big power generators in England and Wales, National Power and PowerGen, have resulted in a package of reductions for existing plants. The outcome of the long-drawn-out negotiations has proved unexpectedly favourable from the point of view of the environment.

Each plant has been set two annual limits for $SO_2$ emissions, which in most cases become successively stricter in 1999 and 2001. The "A limits," which may not be exceeded, have been set with regard to the local effects on the environment, and are tougher for plants such as Fiddlers Ferry that are contributing relatively greatly to the exceeding of the critical loads for acid depositions in their neighbourhood.

The "B limits" are stricter than the A limits and may be exceeded in the case of individual plants, but the companies may not exceed the sum of their B limits. It is expected that similar demands will be made of generators in Scotland and Northern Ireland, since it is hardly likely that the

*Continued on page 3*

# However…

- In the end, the UK met 30% $SO_2$ reduction target with room to spare
  - 1980 emissions: 4.9 million tonnes
  - 2000 target if UK had signed up to the 30% club: 3.4 million tonnes
  - Actual UK emissions, 2000: 1.2 million tonnes

# Why the difference?

- End-of-pipe solutions were not the only ways to reduce sulphur emissions
- Market liberalisation allowed widespread use of natural gas
- Inefficient industries closed
- Some FGD fitted
- Switch to cleaner coal and oil
- No noticeable adverse effects on the UK economy

# This shows that…

- uncertainty is not limited to the quantification of external costs – it also affects estimates of abatement costs

# Command and control legislation

- Emission standards and other performance characteristics for vehicles, specific types of industrial plant, domestic appliances, etc.

# Determination of emission standards

- Are effects so bad that emissions should not be permitted at all?
- What is the Best Available Technique…
- not entailing excessive cost?

# Command and control legislation

- Emission standards and other performance characteristics for vehicles, specific types of industrial plant, domestic appliances, etc.
- Bans on the use and production of certain materials, or processes
- Industrial (etc.) zoning

# Command and control legislation

- Emission standards and other performance characteristics for vehicles, specific types of industrial plant, domestic appliances, etc.
- Bans on the use and production of certain materials, or processes
- Industrial (etc.) zoning
- Environmental quality standards
- IPPC (Integrated Pollution Prevention and Control)

# Determination of environmental quality standards

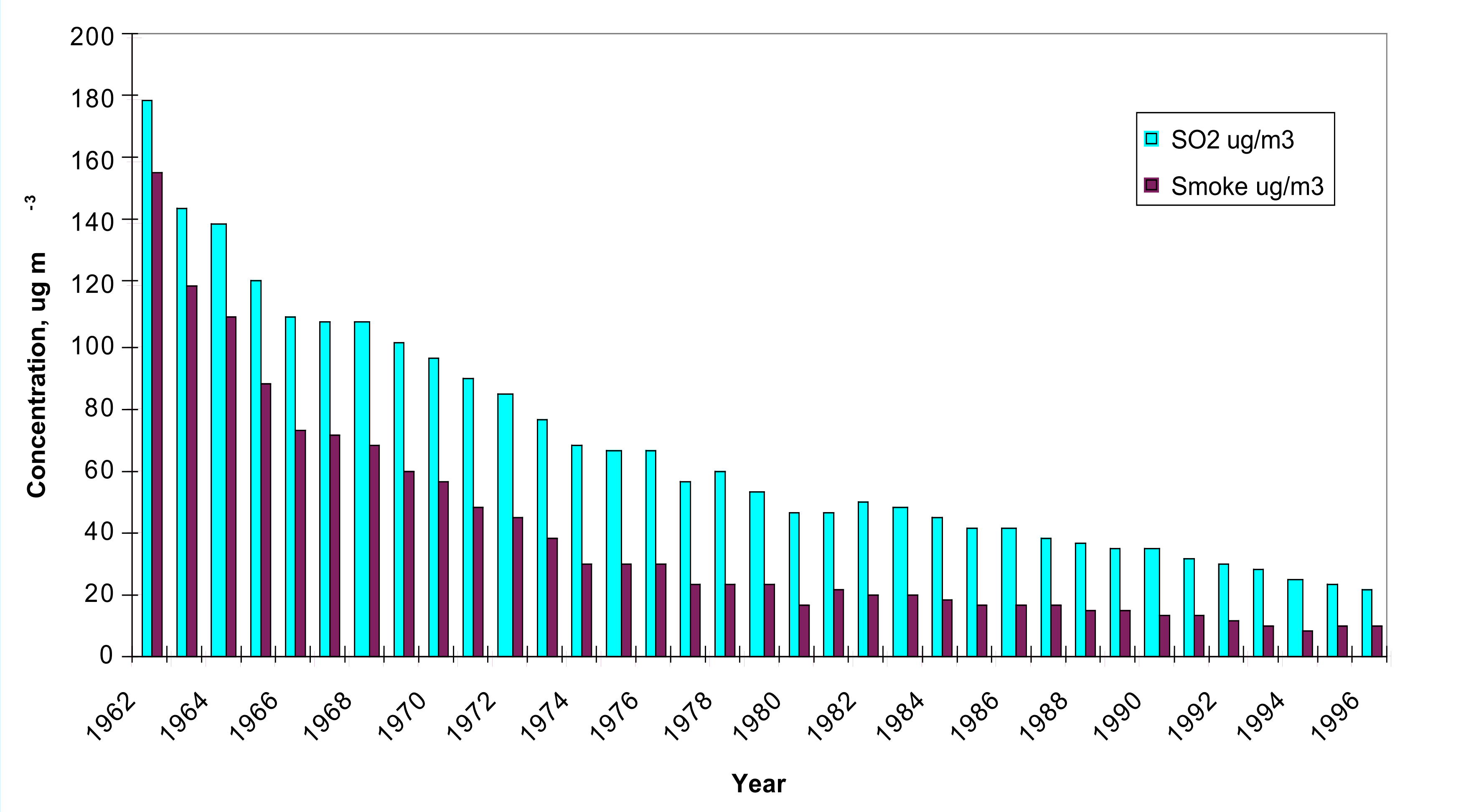
- Primary aim is to protect health and the environment, preferably moving to no-effect levels.
- Basis tends to be protection of the individual, rather than society more generally
- Costs and benefits of action are taken into account, but do not on their own define the legislation.

# Has this legislation worked?

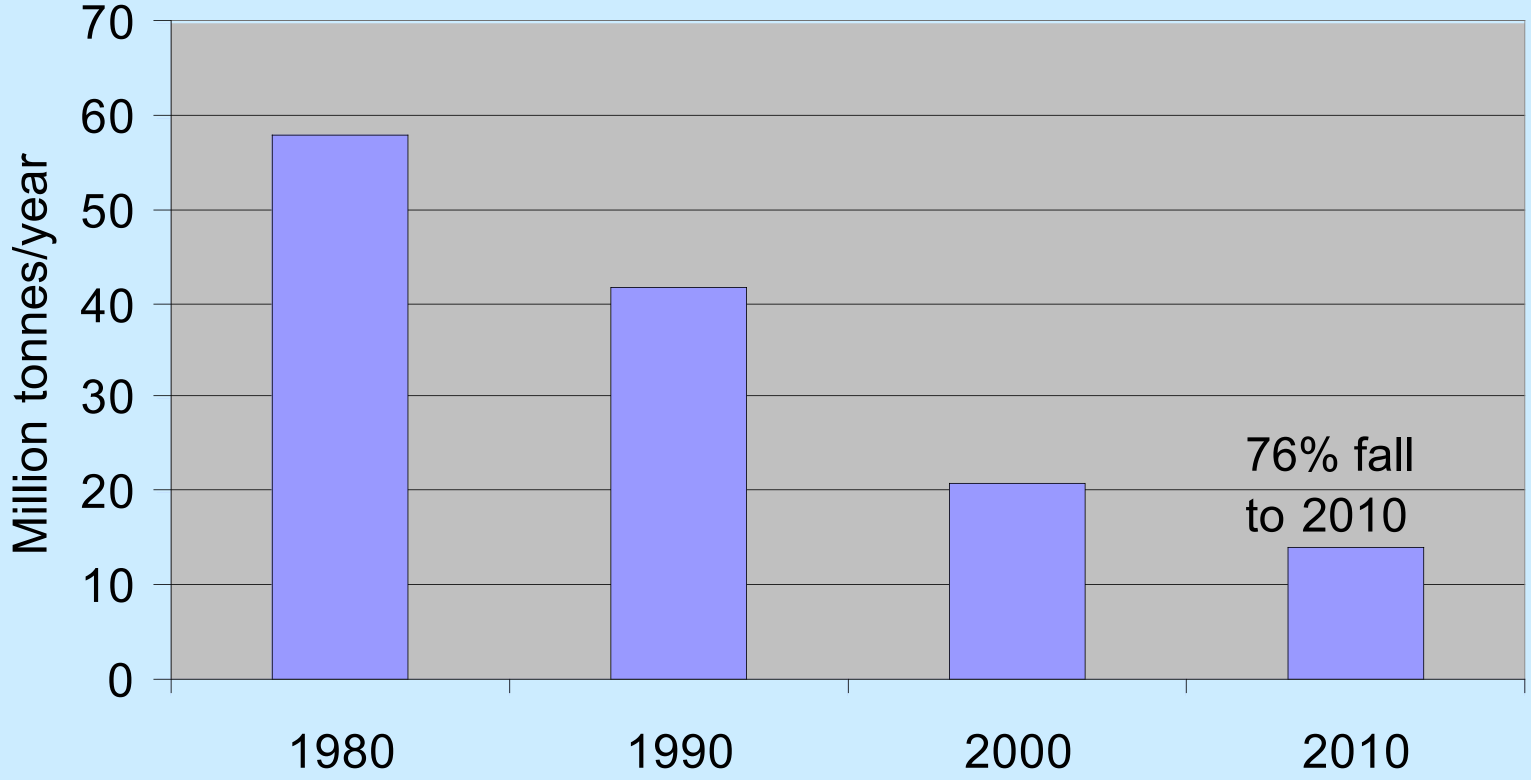
- Urban conditions
- Concentrations
- Emissions

# Sheffield, 1940s and 2003

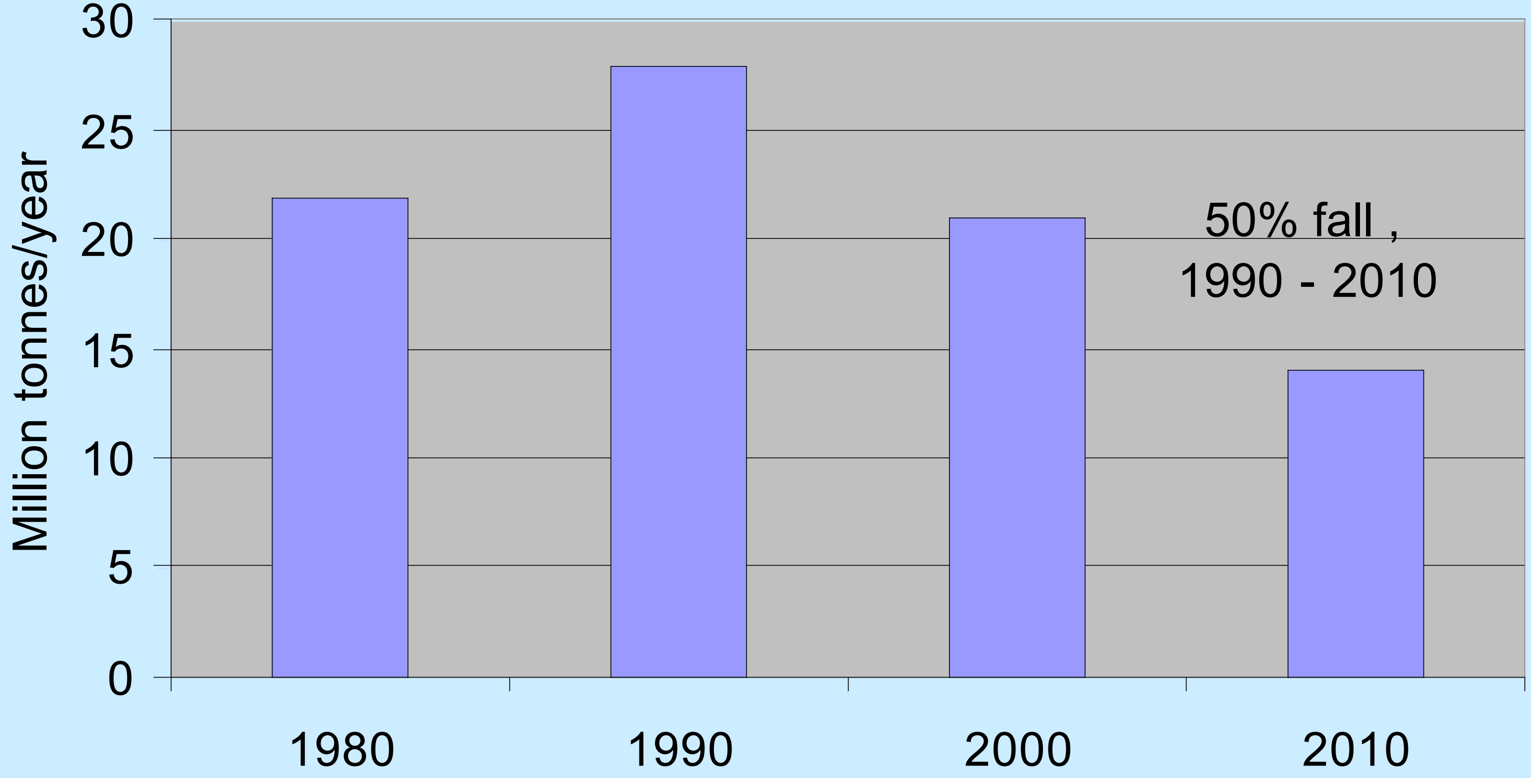
# Concentrations in UK cities



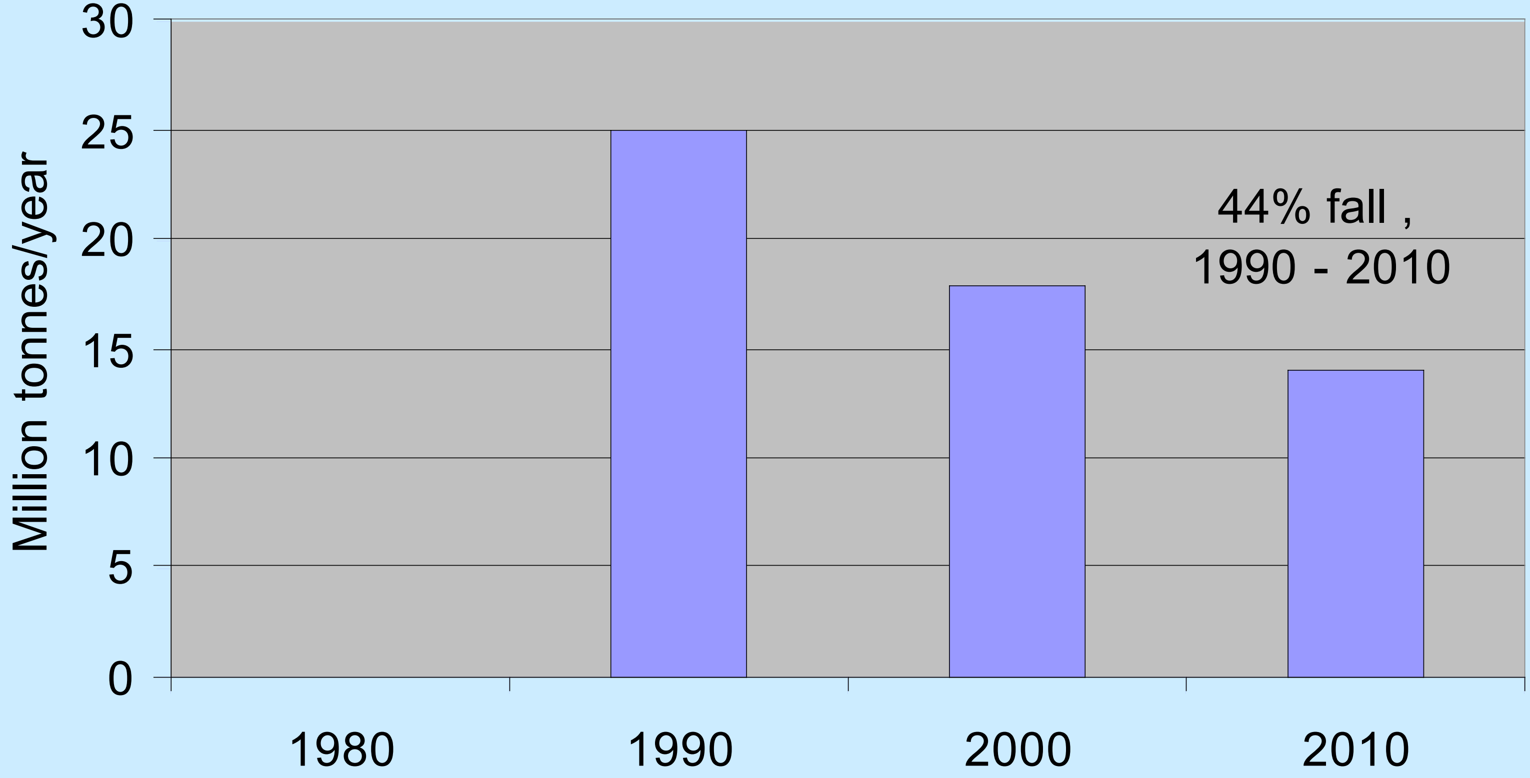
# Emissions in Europe – $SO_2$



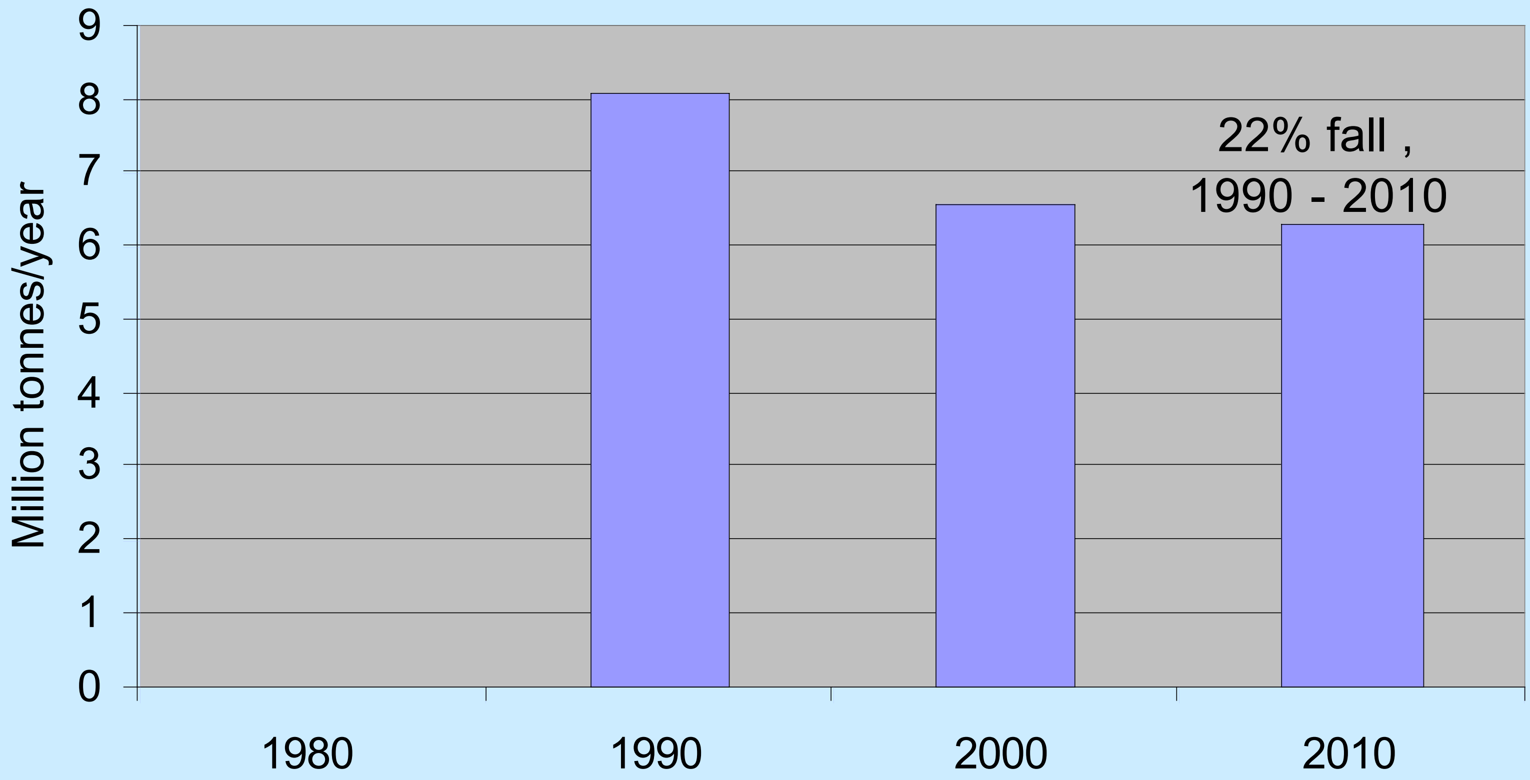
# Emissions in Europe – NOx



# Emissions in Europe – VOCs



# Emissions in Europe – $NH_3$



# Cost-effectiveness

- In any area, there are a potentially large number of different measures that could be implemented to improve air quality.
- Need to evaluate how these compare - what are the best options to achieve the necessary air quality levels.
- One of the criteria in selection of options is cost-effectiveness

# Costs

- Cost to regulators and/or the cost to industry and business and/or cost to the public
- Examples: Cost of fitting abatement technology to stationary source. Cost of excluding lorries from city centre on business.  Cost of  congestion charging schemes on car owners.

# Going beyond costs

- Different measures achieve different levels of pollution abatement
- Costs of implementing different measures varies
- Really cost evaluation needs to reflect both of these = cost-effectiveness
- Typically see presented as costs per tonne abated

E.g. Process 1: 2 tonnes abated for €1,000 =£500 tonne

Process 2: 4 tonnes abated for £4,000 = £1,000/tonne

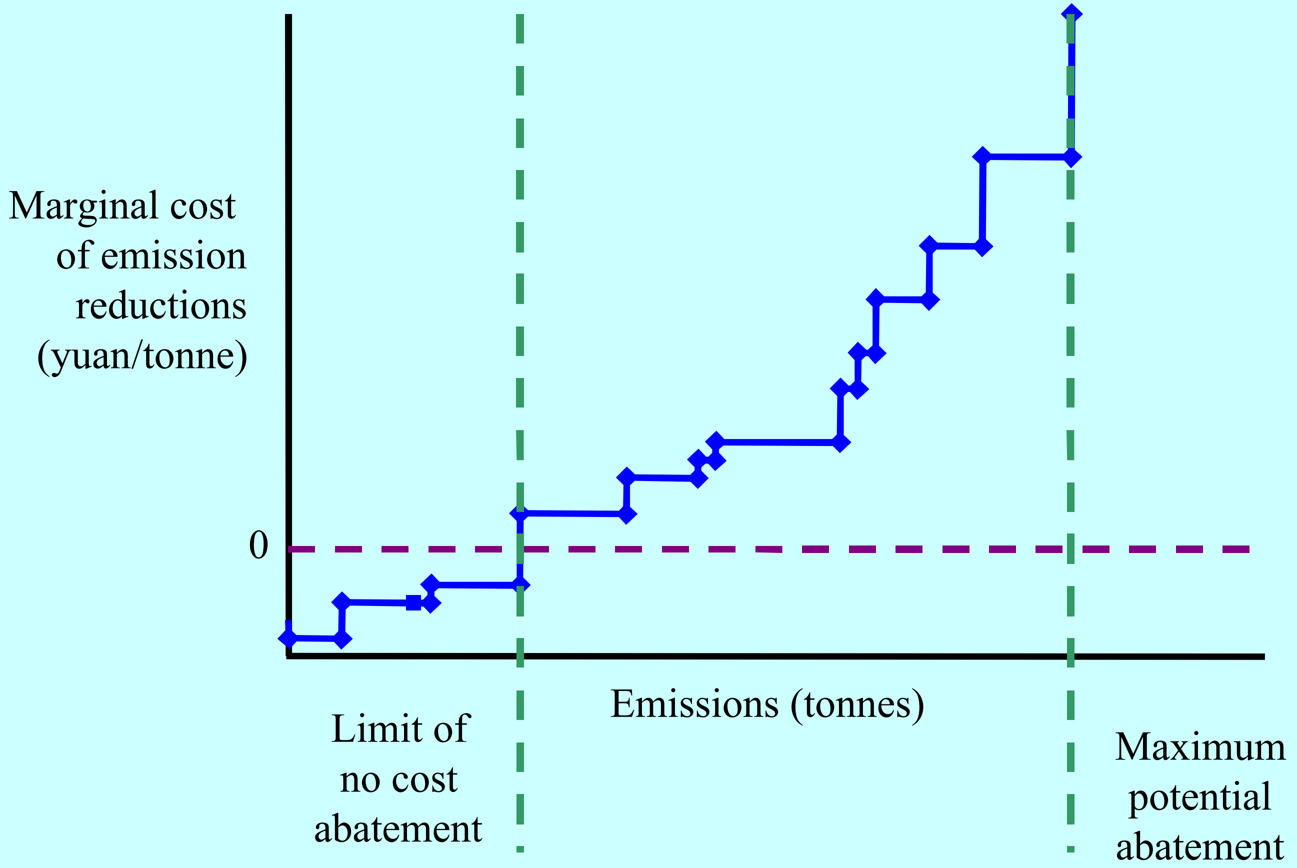
# In an ideal world….

**The measures that achieve greatest air quality reductions would be the cheapest measures to implement, i.e. most cost-effective**

# In our world….

**It gets progressively harder and more costly to achieve stricter and stricter air quality targets (diminishing returns)**

# Cost curves


Marginal cost
of emission
reductions
(yuan/tonne)
0
Emissions (tonnes)
Limit of
no cost
abatement
Maximum
potential
abatement

# Why Use Cost-Effectiveness?

- Expressing different measures in this way allows direct comparison of measures across sources and sectors
- Can rank measures in order of 'most bang for buck'
- For simple case - can pick the cheapest option to achieve target

# Why Use Cost-Effectiveness?

- In many cases, may need more than one option to meet objective.  Maybe several smaller options are more cost-effective than one big measure
- Ranking provides the basis for developing a cost-effective action plan.
- Introduce most cost-effective measures first, progressively add in more expensive measures until achieve air quality target
- Will allow you to achieve the target air quality reductions for least-cost (in the cheapest way possible)

# Problems

- Some types of measure are often omitted, e.g. energy efficiency, fuel switching

# Different metrics

- Cost per tonne (£ per tonne of $NO_x$ abated)
  - Metric based on SOURCE
- Cost per $\mu g/m^3$ (£ per $\mu g/m^3$ of $NO_x$ reduced)
  - Metric based on RECEPTOR

# How to calculate cost-effectiveness

$$\mathrm{PVC}_0^k = \sum_{t=0}^{\mathrm{T}^k} \left[\mathrm{NRC}_t^k + \mathrm{ERC}_t^k + \mathrm{NERC}_t^k\right] \circ \left[1 + r\right]^{-t}$$

- PVC the present value of the total cost stream for environmental protection measure *k* in year zero,
- NRC the non-recurring cost of environmental protection measure *k* in period *t*,
- ERC the energy recurring costs to operate environmental protection measure *k* in period *t*,
- NERC the non-energy recurring costs to operate environmental protection measure *k* in period *t*,
- t, the operating life of environmental protection measure *k*, and
- *r* = the appropriate discount rate.

# Cost-Effectiveness

- To undertake a full cost-effectiveness assessment can be a detailed and time-consuming activity.
- Need to collect detailed data on costs AND make sure this data is presented in equivalent terms
- Need to consider capital costs and operating costs
- Year of study (inflation)
- Costs are usually expressed in terms of an equivalent annual costs (or annualised cost)
- Guidance NETCEN for EEA

  http://www.eea.eu.int

# Summary so far

- Range of policy instruments are available
- Widespread use in Europe and the USA with significant success

- But where do externalities fit in?

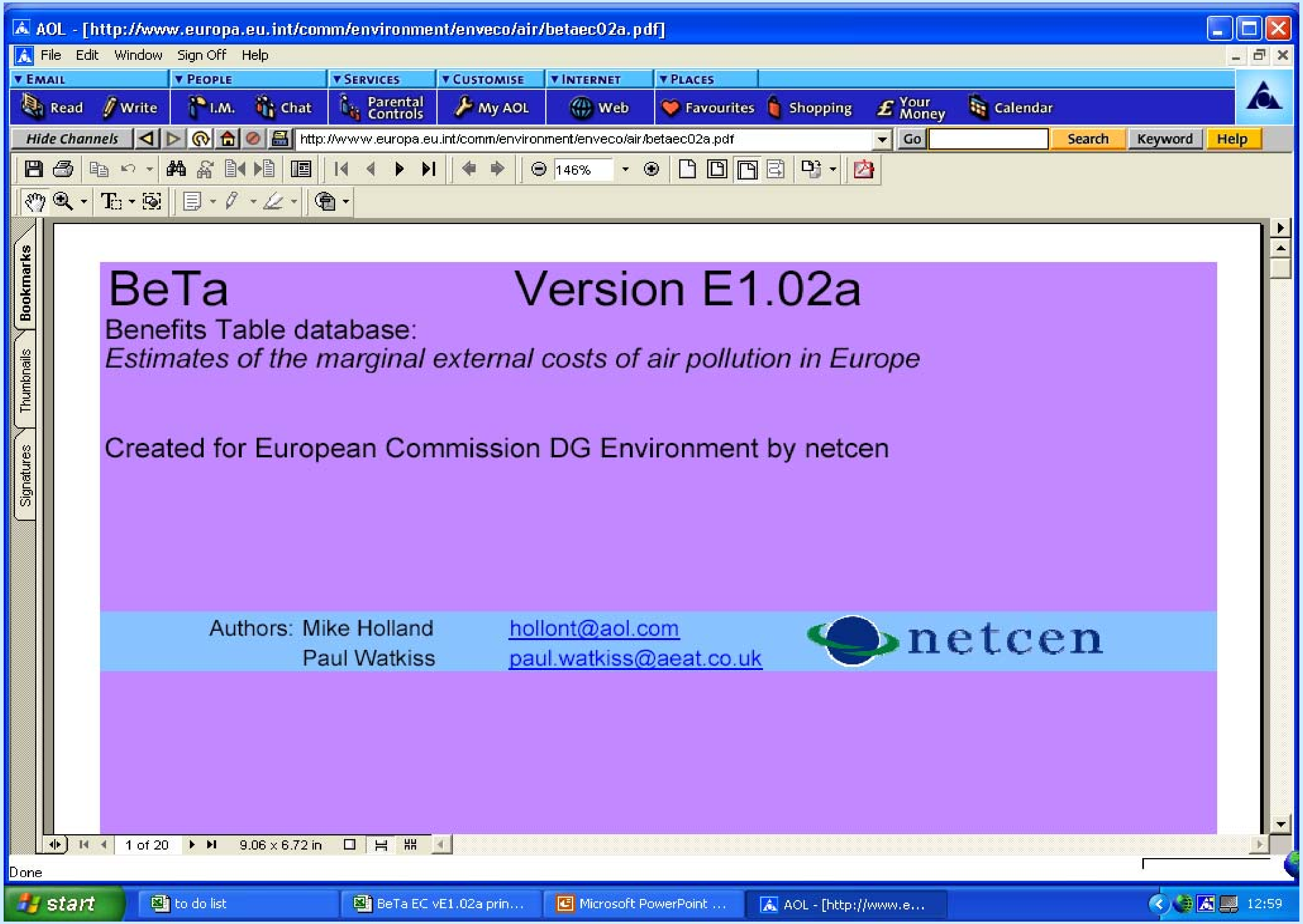
# Examples of the use of external costs in European policy making

- Cost-benefit analysis of standards for Large Combustion Plant
- Cost-benefit analysis of ambient air quality standards (e.g. $PM_{10}$)
- Cost-benefit analysis of National Emission Ceilings
- Defining levels of permitted support for renewable energy technologies
- Setting taxes
- Environmental prioritisation studies

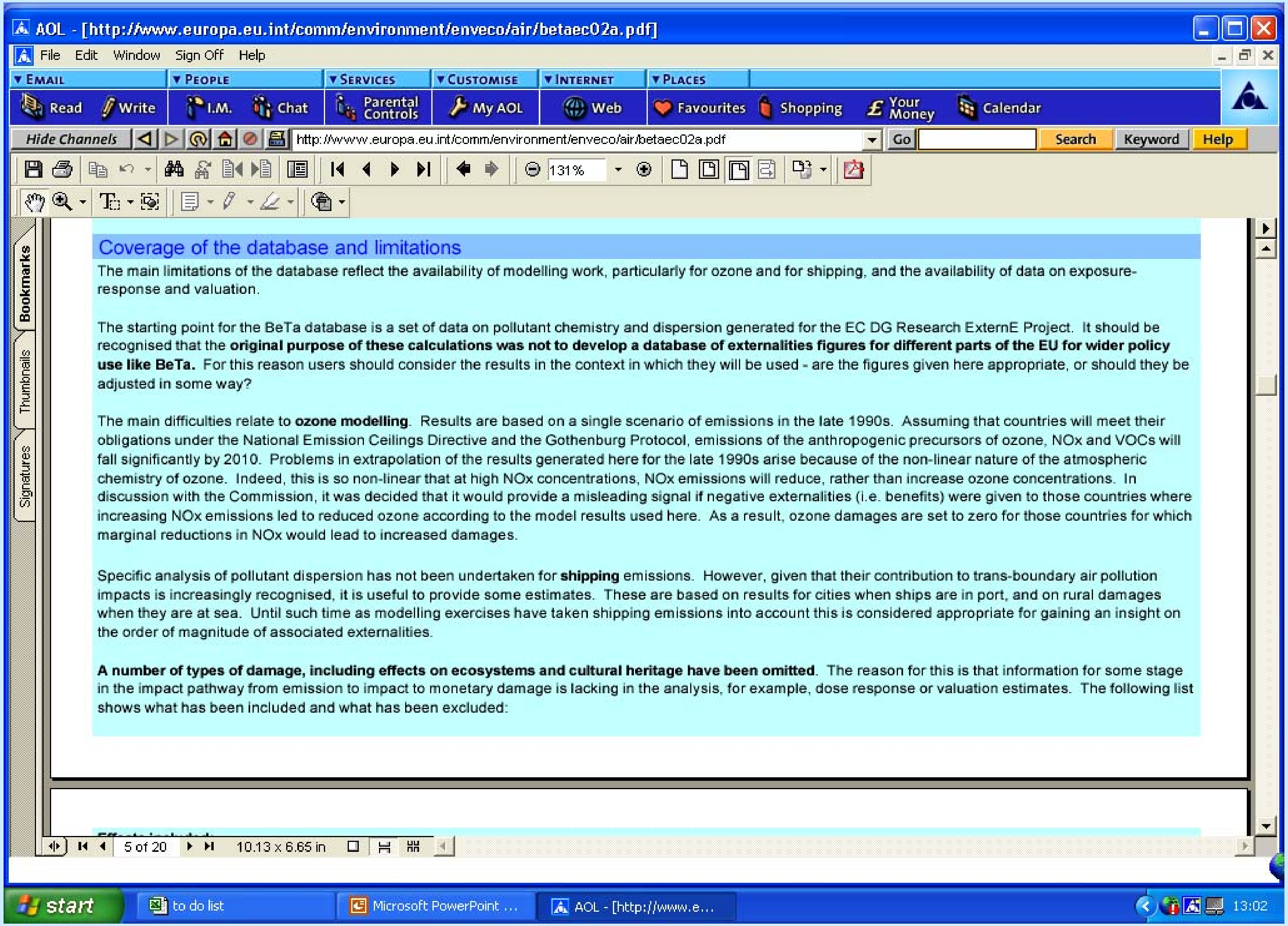
# Basis for calculation in all cases:

- ExternE methodology, some analysis using the EcoSense model, some using other models, e.g. ALPHA
  - ExternE reports available from the European Commission, email: domenico.rossetti-di-valdalbero@cec.eu.int
  - EC policy related studies using externalities are listed on the EU's website at http://www.europa.eu.int/comm/environment/pubs/studies.htm
- Some analysis uses the results generated by ExternE or the BeTa (Benefits Table) database http://www.europa.eu.int/comm/environment/enveco/air/betaec02a.pdf

# BeTa Database



# BeTa provides information on methods…



Coverage of the database and limitations

The main limitations of the database reflect the availability of modelling work, particularly for ozone and for shipping, and the availability of data on exposure-response and valuation.

The starting point for the BeTa database is a set of data on pollutant chemistry and dispersion generated for the EC DG Research ExternE Project. It should be recognised that the **original purpose of these calculations was not to develop a database of externalities figures for different parts of the EU for wider policy use like BeTa.** For this reason users should consider the results in the context in which they will be used - are the figures given here appropriate, or should they be adjusted in some way?

The main difficulties relate to **ozone modelling**. Results are based on a single scenario of emissions in the late 1990s. Assuming that countries will meet their obligations under the National Emission Ceilings Directive and the Gothenburg Protocol, emissions of the anthropogenic precursors of ozone, NOx and VOCs will fall significantly by 2010. Problems in extrapolation of the results generated here for the late 1990s arise because of the non-linear nature of the atmospheric chemistry of ozone. Indeed, this is so non-linear that at high NOx concentrations, NOx emissions will reduce, rather than increase ozone concentrations. In discussion with the Commission, it was decided that it would provide a misleading signal if negative externalities (i.e. benefits) were given to those countries where increasing NOx emissions led to reduced ozone according to the model results used here. As a result, ozone damages are set to zero for those countries for which marginal reductions in NOx would lead to increased damages.

Specific analysis of pollutant dispersion has not been undertaken for **shipping** emissions. However, given that their contribution to trans-boundary air pollution impacts is increasingly recognised, it is useful to provide some estimates. These are based on results for cities when ships are in port, and on rural damages when they are at sea. Until such time as modelling exercises have taken shipping emissions into account this is considered appropriate for gaining an insight on the order of magnitude of associated externalities.

**A number of types of damage, including effects on ecosystems and cultural heritage have been omitted**. The reason for this is that information for some stage in the impact pathway from emission to impact to monetary damage is lacking in the analysis, for example, dose response or valuation estimates. The following list shows what has been included and what has been excluded:

# …and provides results for rural, urban and marine locations

AOL - [http://www.europa.eu.int/comm/environment/enveco/air/betaec02a.pdf]

## RURAL

*Marginal external costs of emissions in rural areas, year 2000 prices*

| | SO2 | NOx | PM2.5 | VOCs |
|---|---|---|---|---|
| Austria | 7,200 | 6,800 | 14,000 | 1,400 |
| Belgium | 7,900 | 4,700 | 22,000 | 3,000 |
| Denmark | 3,300 | 3,300 | 5,400 | 7,200 |
| Finland | 970 | 1,500 | 1,400 | 490 |
| France | 7,400 | 8,200 | 15,000 | 2,000 |
| Germany | 6,100 | 4,100 | 16,000 | 2,800 |
| Greece | 4,100 | 6,000 | 7,800 | 930 |
| Ireland | 2,600 | 2,800 | 4,100 | 1,300 |
| Italy | 5,000 | 7,100 | 12,000 | 2,800 |
| Netherlands | 7,000 | 4,000 | 18,000 | 2,400 |
| Portugal | 3,000 | 4,100 | 5,800 | 1,500 |
| Spain | 3,700 | 4,700 | 7,900 | 880 |
| Sweden | 1,700 | 2,600 | 1,700 | 680 |
| UK | 4,500 | 2,600 | 9,700 | 1,900 |
| EU-15 average | 5,200 | 4,200 | 14,000 | 2,100 |

Units:
€/tonne SO2
€/tonne NO2
€/tonne PM2.5
€/tonne VOC

## URBAN

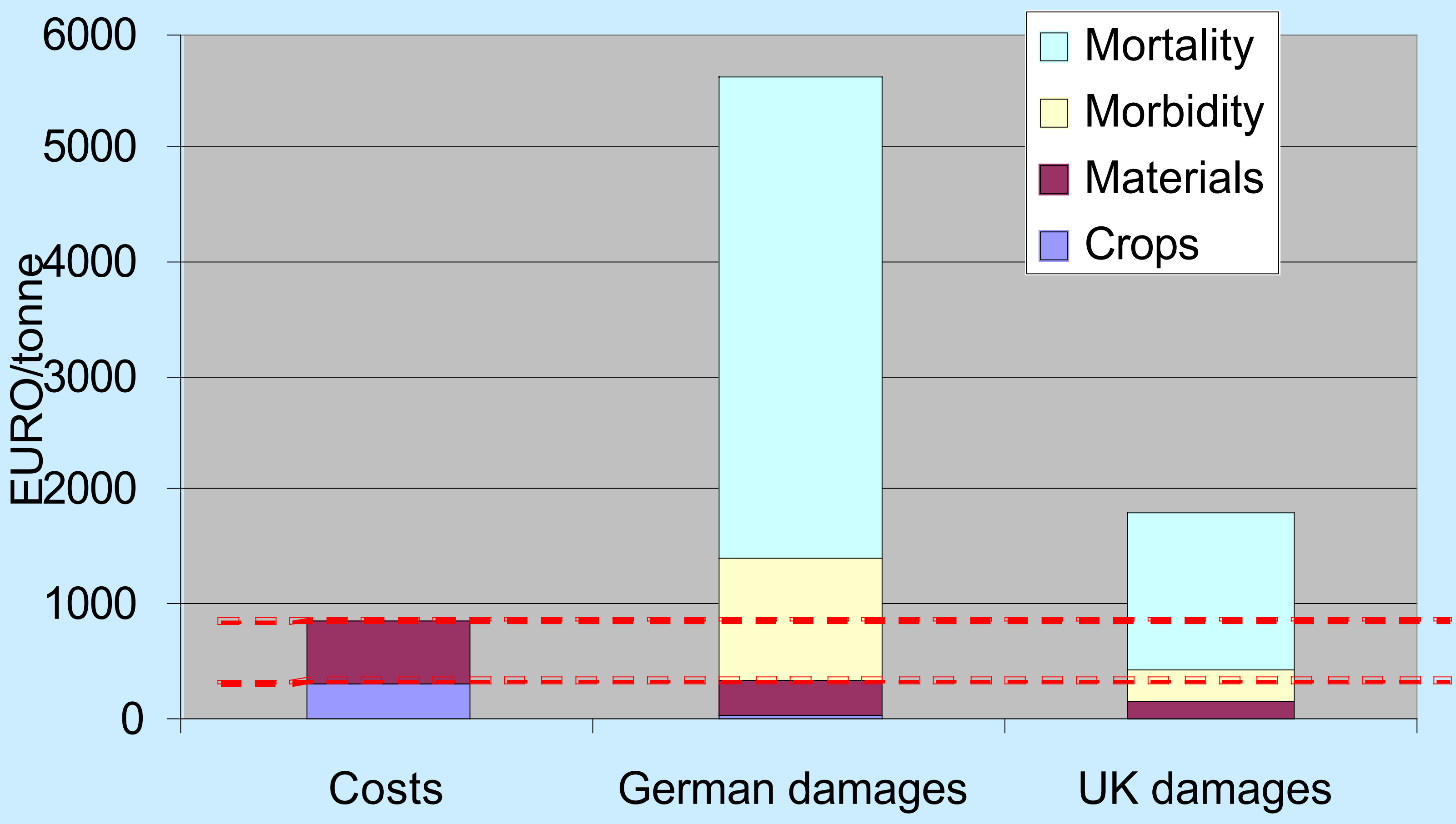
*Marginal external costs of emissions in cities, year 2000 prices*

Urban results for NOx and VOCs are taken to be the same as the rural effects, given that quantified impacts are linked to forn

# EU Acidification Strategy and Large Combustion Plant Directive

- Externalities analysis used to estimate the benefits of these policies in terms of reduced damage to health, materials and crops.
- Health effects dominated
- Uncertainty assessment conducted specific to the relationship between costs and benefits

# EU Acidification Strategy and Large Combustion Plant Directive



# Ambient Air Quality Standards

- Analysis carried out in a similar way to the Acidification Strategy and LCPD
- BUT much finer scales needed to account for spatial variation in concentrations in cities.

# EU Directive on the Sulphur Content of Marine Fuels

- External costs analysis integral to the justification of the Commission's recommendation
  - http://europa.eu.int/eur-lex/en/com/pdf/2002/act0595en01/2.pdf

# EU Directive on the Sulphur Content of Marine Fuels

| Table 3.2 Monetized benefits of emissions reductions | | | |
|---|---|---|---|
| **Pollutant** | **Location of emission reduction** | **Air quality benefit** | |
| | | € per tonne reduced (average) | Explanation |
| $SO_2$ | North Sea, Baltic Sea & English Channel (SOxECA) | 3,933 | Reduced impact of $SO_2$ and sulphate particles on health, and SO2 and acidity on materials |
| $SO_2$ | East Atlantic & Northern Mediterranean | 4,600 | Reduced impact of $SO_2$ and sulphate particles on health, and $SO_2$ and acidity on materials |
| $SO_2$ | EU port areas | 8,200 | Benefits as above, but higher value because more people are affected |
| PM | EU port areas | 30,500 | Reduced impact on human health (high value as PM is particularly harmful) |
| PM | SOxECA port areas | 27,650 | Reduced impact on human health (slightly lower value than above as SOxECA countries have slightly lower average population density than EU) |
| NOx | EU port areas | 4,200 | Reduced impact of nitrate particles on health and ozone on health and crops |

# National Emission Ceilings Directive and Gothenburg Protocol

- Quantified benefits for each country of different targets for $SO_2$, VOCs, NOx and $NH_3$
- Compared against costs calculated using the RAINS model
- Used standard sensitivity analysis and a stratified sensitivity analysis to test the likely importance of uncertainties

# National Emission Ceilings Directive and Gothenburg Protocol

- Concluded that most sensitivities did not make much difference to the results
- Significant variation in the magnitude of externalities around Europe – largest for countries in the middle of Europe
- For most countries, benefits exceeded costs despite the success of past legislation

# Future EU air quality policy

- Future development of European air quality strategies will largely be carried out under the framework of the CAFE programme (Clean Air for Europe) (check EU website for details)

# Support for renewables

- Based levels of permitted support in part on the difference in externalities between fossil and renewable technologies
- No account taken of uncertainties

# Defining environmental priorities

- Data on a large number of environmental risks were collated
- Where possible, results were expressed as both impacts and then monetised
- This highlighted the problems associated with the largest economic effects
- Ideally, prioritisation would have been combined with cost-effectiveness analysis