ExternE-style CBA and EU Directives






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(with acknowledgements to other members of the CAFE-CBA team)

Which Directives have used or are using ExternE-style CBA?

- Past Directives
  - Emission standards for industrial plant
  - Air quality standards
  - National emission ceilings
- Recent work
  - CAFE (Clean Air For Europe)
  - IPPC (Integrated Pollution Prevention and Control)

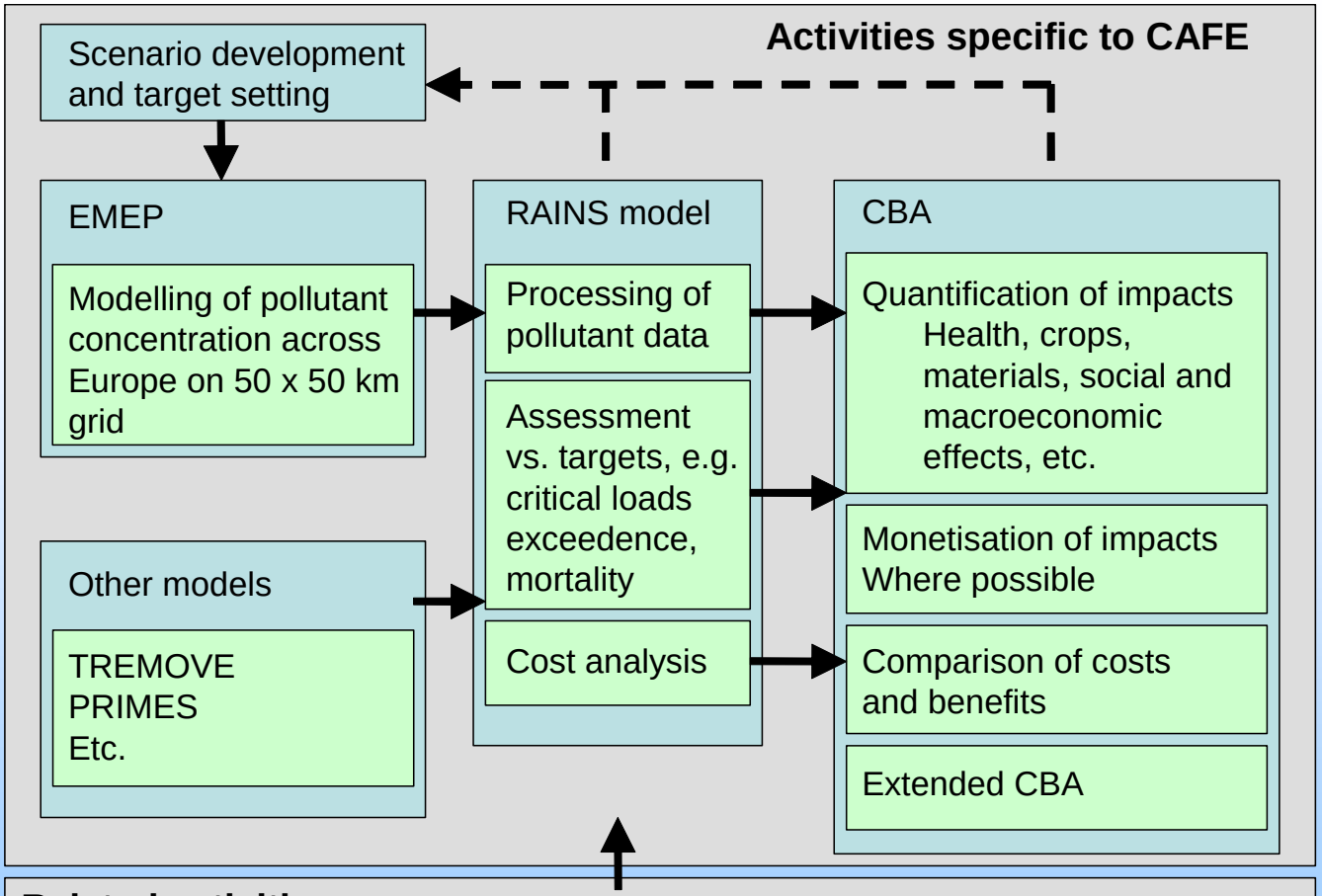
What is CAFE?

- CAFE = Clean Air For Europe Programme
- Currently developing ‘Thematic Strategy on Air Pollution’
  - Revised National Emission Ceilings Directive
  - $PM_{2.5}$ standard
  - Revised Large Combustion Plant Directive
  - Emission standards for mobile sources
  - Etc.

Impacts of primary interest to CAFE

- Health
  - PM – Chronic effects on mortality
  - Ozone – Acute effects on mortality
- Ecosystem damage

CAFE analytical framework



Related activities

EC DG Research Programmes

UNECE Working Groups under Convention on Long-Range Transboundary Air Pollution (CLRTAP)

WHO Europe commentary on air pollution impacts

Roles of the different models

- PRIMES: Energy sector modelling, forecasting
- TREMOVE: Transport sector modelling, forecasting
- EMEP: Dispersion modelling, pollutant chemistry
- RAINS: Cost-effectiveness analysis, optimisation of emission strategies against pre-defined targets
- CAFE-CBA/ALPHA2: Quantification of benefits and comparison with costs (cost-benefit analysis)

Cost-effectiveness analysis vs. cost-benefit analysis

- Cost effectiveness analysis
  - What is the most efficient way to meet targets for human health improvement, ecological protection, etc.
  - Does NOT say if it is worth reaching targets
- Cost-benefit analysis
  - Comparison of costs and benefits – is it worth reaching targets?
- Alternatives to CBA:
  - MCA on key impact estimates
  - Pure political assessment of whether a specific target is worth meeting

Impacts considered quantitatively in CAFE

- Health
  - PM – chronic mortality, infant mortality, chronic and acute effects on morbidity
  - Ozone – Acute effects on mortality and morbidity
- Crop damage from ozone
- Materials damage, mainly SO_2 and acidity
- Ecosystem damage (but not in economic terms)
- Macroeconomic effects (via the GEM-E3 model)

- Changes in CO_2 emissions relative to Kyoto

Development of the CAFE CBA methodology

- Development started from ExternE impact pathway analysis, but adapted following discussion with stakeholders
  - WHO
  - CLRTAP task forces
  - EU Member States
  - European institutions
  - Industry
  - NGOs
  - Formal peer review by US experts
- 3 reports published:
  - Volume 1: Overview
  - Volume 2: Health Impact Assessment
  - Volume 3: Uncertainty appraisal

Why are ExternE and CAFE-CBA methods not identical?

- ExternE is more a research project, and so less constrained
- CAFE is more influenced by available consensus…
- …and is pragmatic in applying alternative positions supported by a significant body of experts
- Although there are differences between CAFE and ExternE, they are in the detail, not the general structure of the methodology

CAFE-CBA methodology

- Impact pathway approach, as ExternE, but…
- …Some apparently important differences to ExternE methods
  - Particularly for chronic mortality impacts (No differentiation by type of particle, risk factor used, quantification of number of deaths, alternative valuations by deaths/VSL and YOLLs/VOLY)
  - 35 ppb cut point for ozone – health assessment
  - ‘Extended CBA’
- CAFE has made some advances that will come into ExternE…
- …but in other places, adopts a more conservative approach to quantification than developed by ExternE

Illustrative Results

Baseline scenarios (where are we in 2000, where will we be in 2020?)

Baseline Health Impacts – EU25

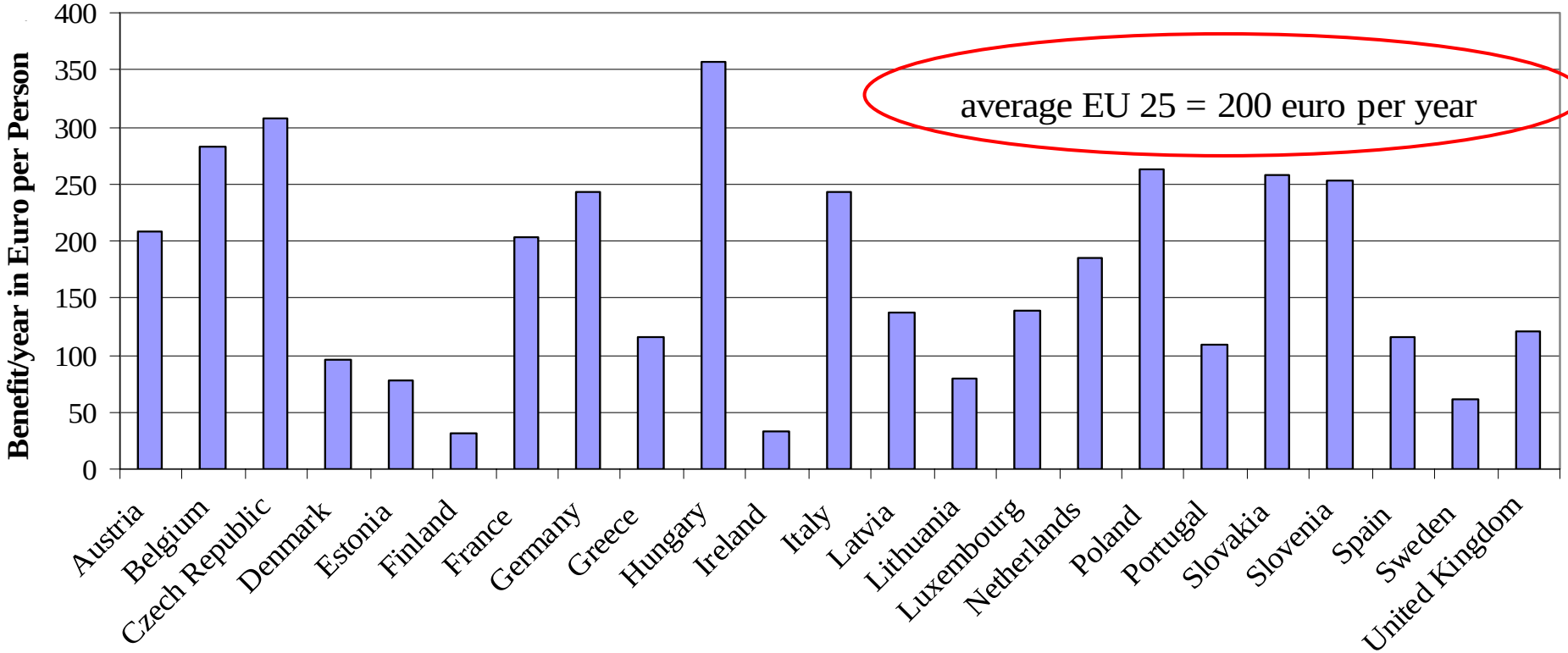
End point		Baseline in 2000	Current leg. 2020 (w/Climate Policy)	Difference 2020 and 2000
Acute Mortality	O_3	21 400	20 700	745
Respiratory hospital admissions	O_3	14 000	20 000	-6 000
Minor Restricted Activity Days	O_3	53 924 000	42 227 000	11 697 000
Respiratory medication Use (Children)	O_3	21 413 000	12 897 000	8 516 000
Respiratory medication Use (Adults)	O_3	8 837 000	8 136 000	701 000
Cough and LRS (children)	O_3	108 056 000	64 955 000	43 101 000
Chronic mortality *	PM	3 001 000	1 900 000	1 101 000
Chronic mortality *	PM	288 300	208 000	80 100
Infant mortality	PM	562	271	292
Chronic bronchitis	PM	135 700	98 400	37 300
Respiratory hospital admissions	PM	51 400	32 600	18 900
Cardiac hospital admissions	PM	31 700	20 100	11 600
Restricted activity days (RADs)	PM	288 292 000	170 955 700	117 337 000
Respiratory medication Use (children)	PM	3 510 000	1 548 700	1 961 000
Respiratory medication Use (adults)	PM	22 990 000	16 055 000	6 935 000
LRS among children	PM	160 349 000	68 819 000	91 529 000
LRS in adults with chronic symptoms	PM	236 498 000	159 724 000	76 774 000

Summary – Health Valuation – EU25

	2000 (€bn)		2020 (€bn)		Difference (€bn)	
	Low estimate	**High estimate**	**Low estimate**	**High estimate**	**Low estimate**	**High estimate**
O_3 mortality	1.1	2.5	1.1	2.4	0.0	0.1
O_3 morbidity	6.3	6.3	4.2	4.2	2.1	2.1
PM mortality	157.7	582.3	99.7	420.1	58.0	162.2
PM morbidity	77.9	77.9	49.3	49.3	28.6	28.6
Total	**243.0**	**669.0**	**154.3**	**476.0**	**88.7**	**193.0**

- The impact (the benefit) of implementing current legislation up to 2020 is valued at between €89 billion to €193 billion

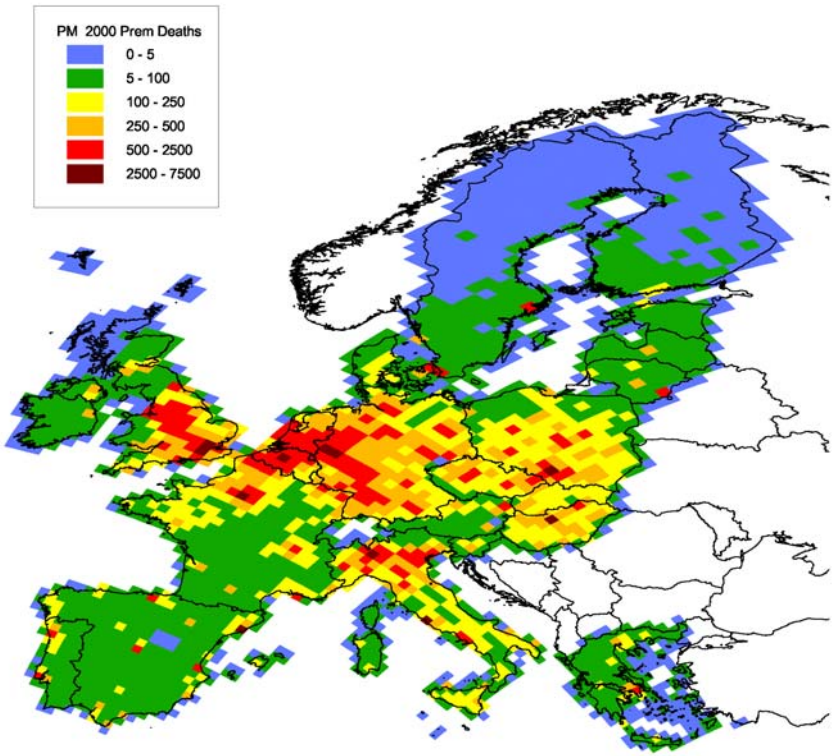
Health Benefits (Euro per Person)
Policies from 2000 to 2020 by Member State
Low Estimate



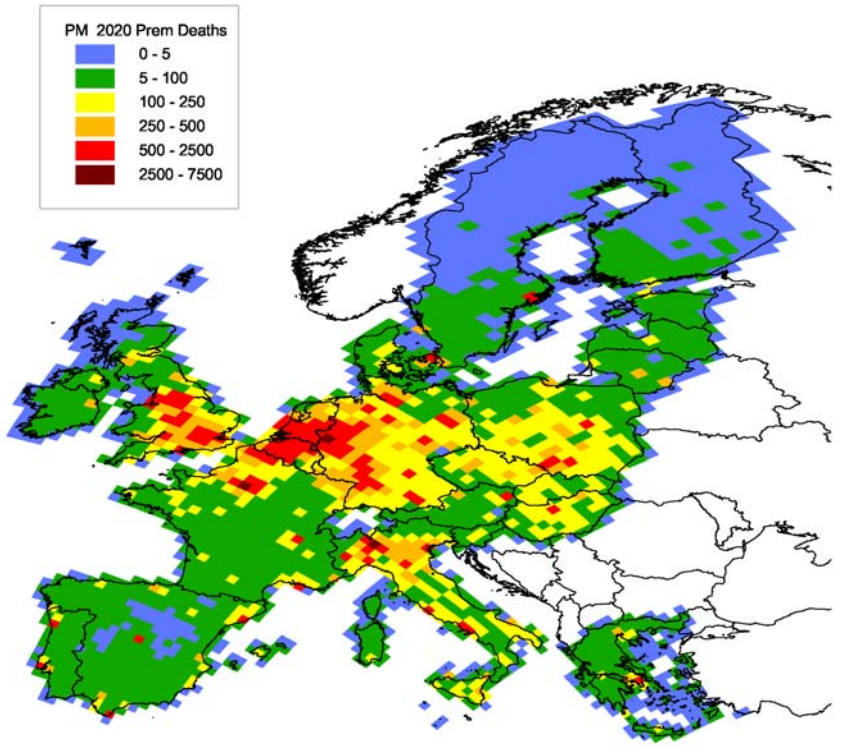
(YOLL – VOLY median)

High estimate gives a value of 430 Euro per person per year

Distribution of PM related mortality (anthropogenic PM only excluding SOA)



2000



2020

Analysis of Policy Scenarios

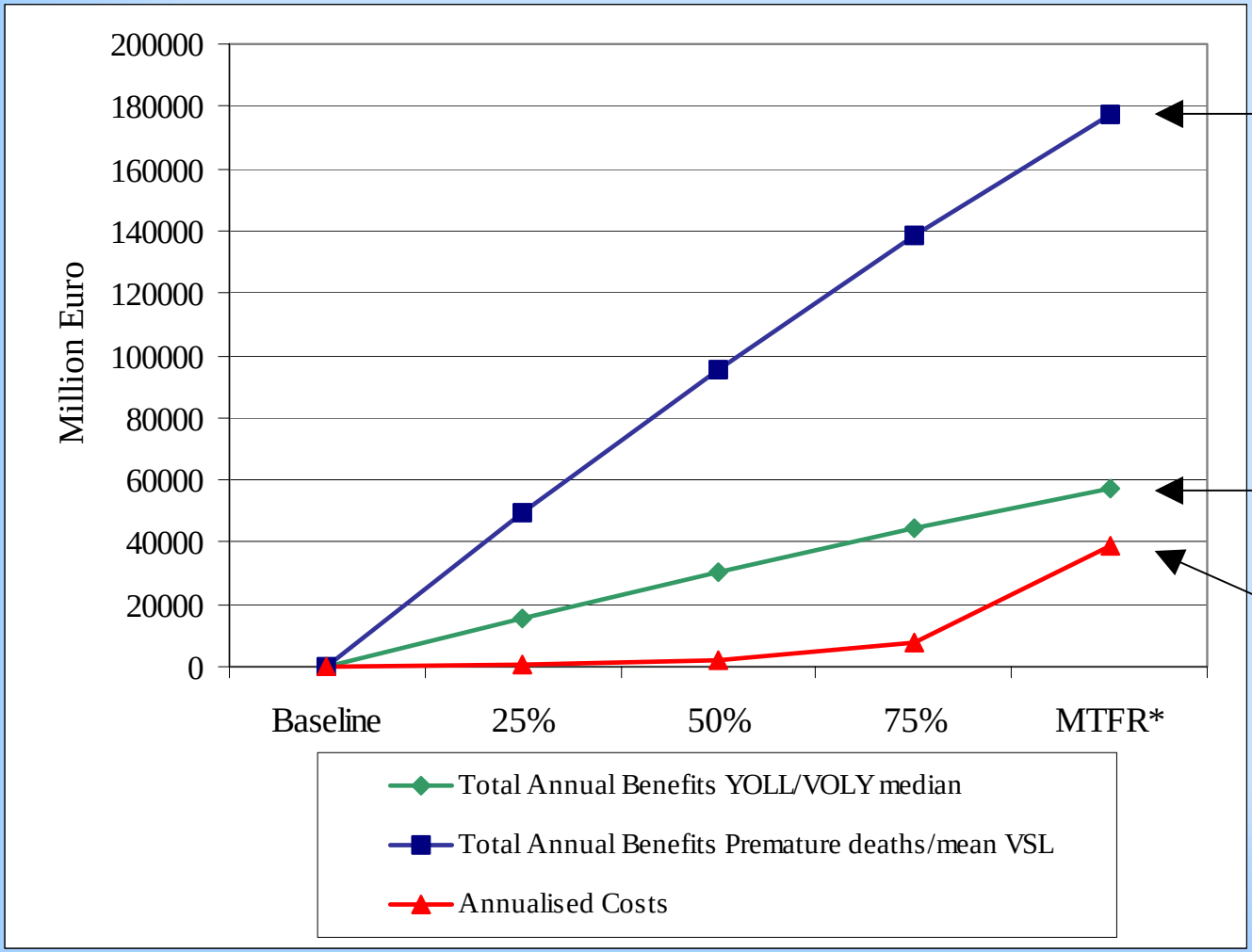
Preliminary results

Gap Closure relative to MTFR for PM exposure

Baseline 2020 - CLE Climate Policy (CP)

- Maximum Technical Feasible Reduction (MTFR) from measures included in the RAINS model represents 100% gap closure
  - 'MTFR' used here does not include Euro V/VI standards, abatement from shipping, some retrofit options, etc.
- Also investigated 25%, 50%, 75% gap closure for PM exposure

Summary – Annual Health Benefits EU25

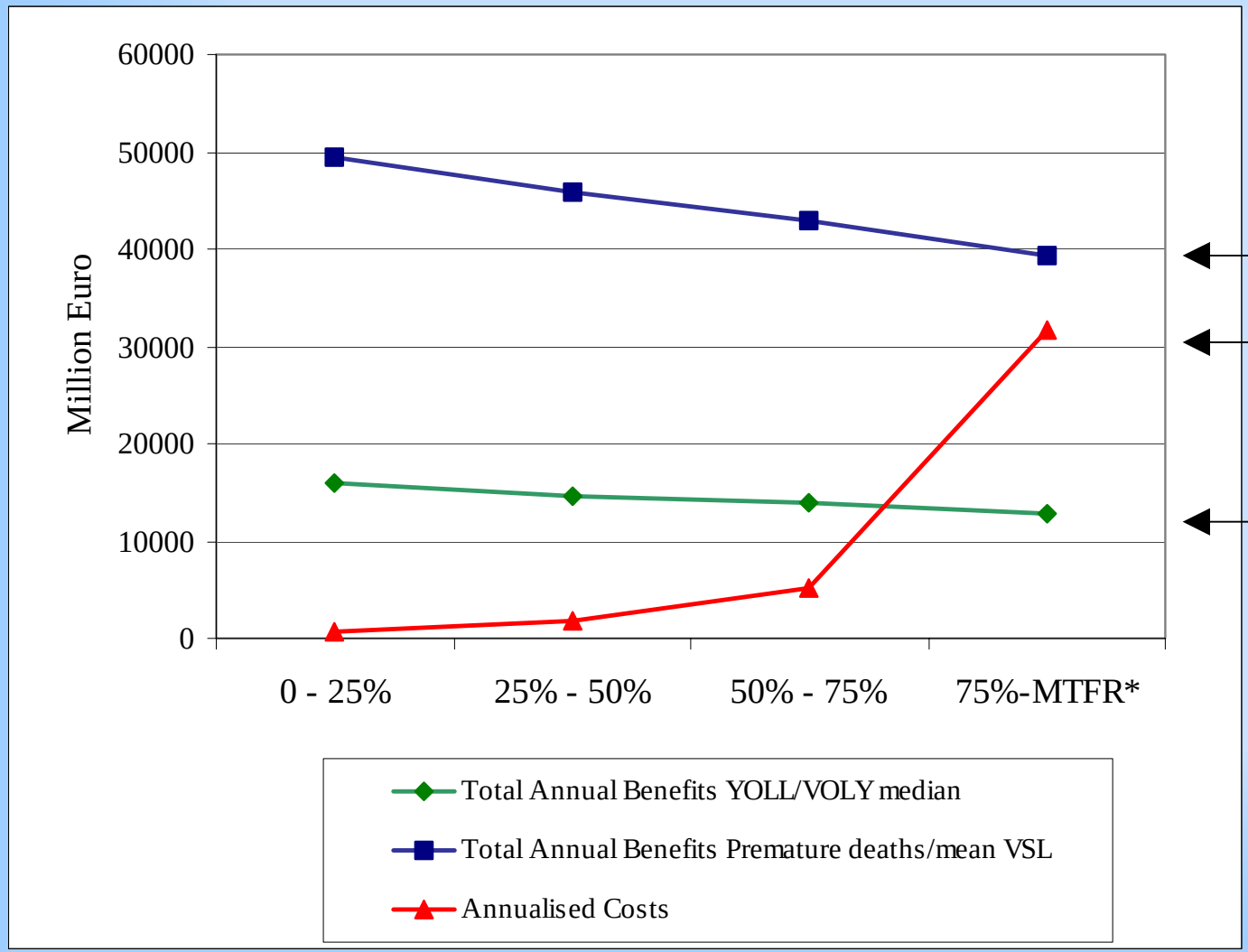


High estimate
€ 178 billion

Low estimate
€ 57 billion

Costs
€39 billion

Incremental Annual Health Benefits EU25



Incremental Health Valuation – EU25

Summary EU25 Health Valuation (Million) – benefits low & high estimate

	Baseline to 25% Gap Closure	25 to 50% Gap Closure	50 to 75% Gap Closure	75% to MTFR exc Euro 5/6
Incremental Annual Benefits	15870 to 49487	14668 to 45861	13841 to 42840	12697 to 39348
Incremental Annualised Costs	617	1825	5087	31594
Incremental Benefit:Cost Ratio	26 to 80	8 to 25	3 to 8	0.4 to 1.2

Need to consider additional benefits, effects of uncertainty

Conclusions on scenario runs

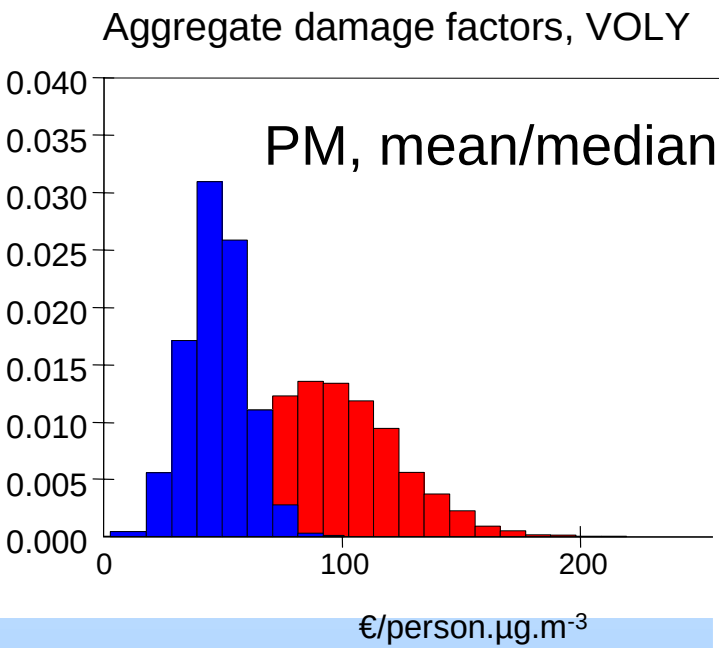
- Quantified benefits look likely to exceed costs by a significant margin, certainly up to ~75% gap closure.
- Pattern of declining benefit to cost ratio as move towards MTFR
- Sharp decrease in benefit to cost ratio above 75% for most Member States
- A more disaggregated view is needed to investigate marginality, relative merits of abating different pollutants, etc.
- Sensitivity to method for PM mortality valuation is limited, even when all other impacts are omitted

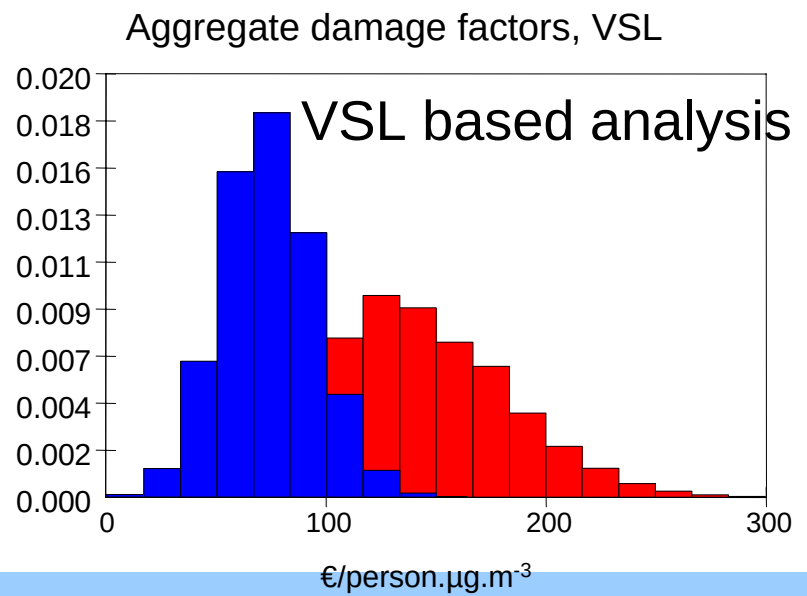
Analysis of uncertainties and variability

- Investigates:
  - Statistical uncertainties
  - Sensitivities, mainly to methodological variation
  - Biases – unquantified aspects that give systematic bias to over- or under-estimation

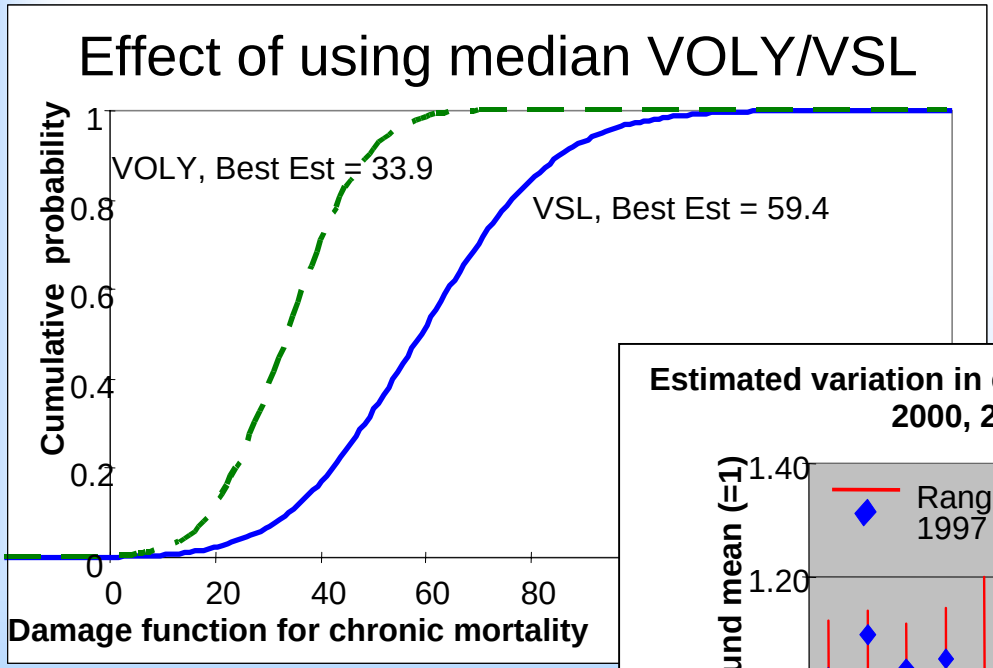
- Following figures highlight some parts of the analysis in each area but not all

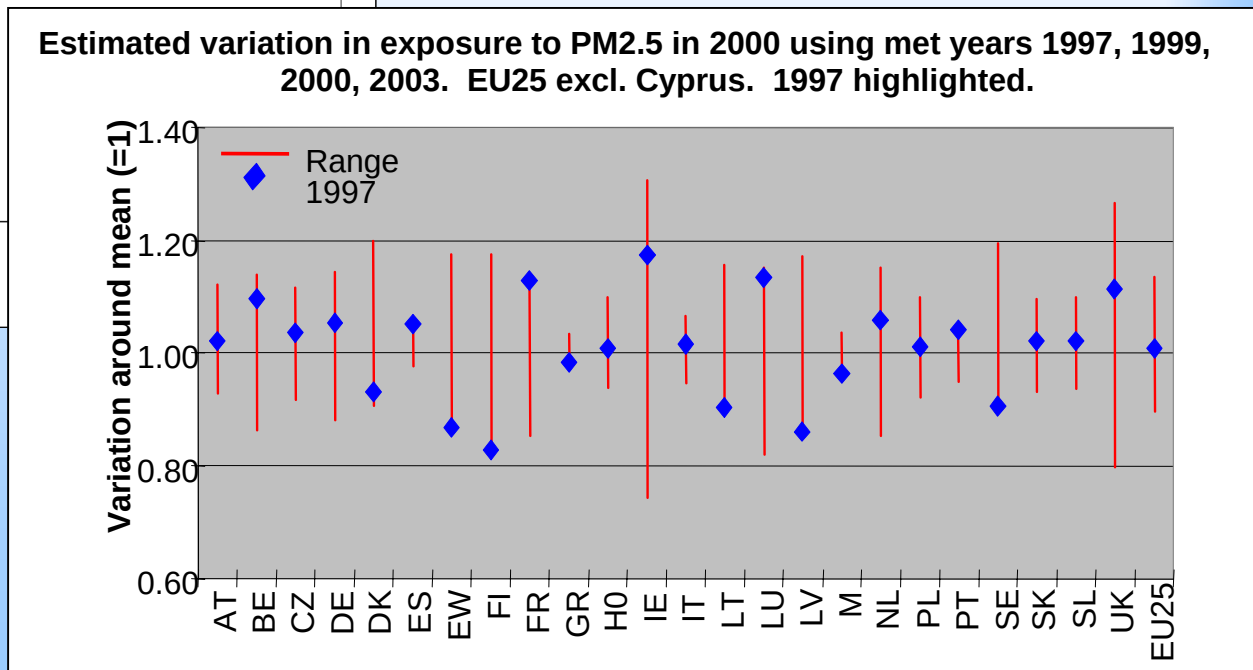
Statistical uncertainties
This example: Aggregate damage factors (all PM health effects)





Sensitivities (examples)





Effect of choice of different meteorological year

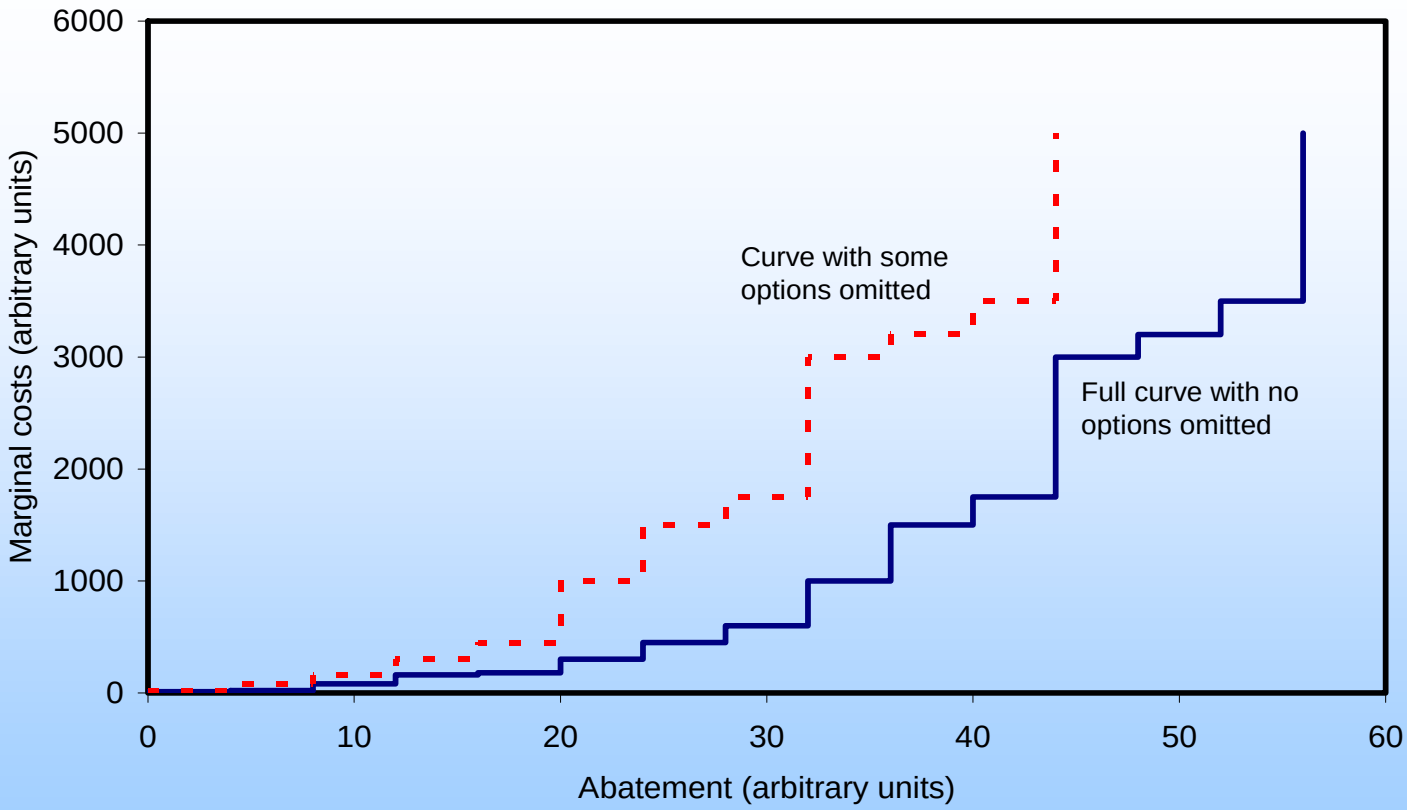
Why is choice of VOLY or VSL not so important as it may first appear?

- Valuation:
  - Median VOLY: €52,000
  - Median VSL: €980,000
  - Factor 20 difference
- But…
  - More years of life estimated to be lost than associated deaths
  - Other effects are unaffected by this parameter
  - This cancels out much of the difference from valuation

Key biases

- **EMEP modelling**
  - Omission of secondary organic aerosols
  - (Choice of meteorological year)
- **RAINS modelling**
  - Emission starting point bias
  - Omission of some abatement techniques
  - Lack of account of future technical developments
  - Lack of differentiation of particle species by effect
- **Benefits modelling**
  - Omission of impacts on ecosystems, cultural heritage, etc.
  - Lack of differentiation of particle species by effect

Illustrative cost curves
(note - this ignores cost-saving measures)



Conclusions on uncertainty from CAFE-CBA

- Necessary to expand on the methods of Rabl and Spadaro because of the CAFE context
- Tighter ‘headline’ confidence interval than Rabl and Spadaro for the benefits analysis…
- …but some elements of the R+S analysis dealt with differently for CAFE or are less relevant
- Need to factor in uncertainty in abatement cost elements also

CAFE-CBA reports

- http://cafe-cba.org/
  - Methodology report
    - Volume 1: Overview
    - Volume 2: Health Impact Assessment
    - *Volume 3: Uncertainty analysis*
  - Peer review of the draft methodology
  - *Baseline results*
  - *Response to comments made by UNICE*
  - *Marginal estimates of damage per tonne emission*
  - *Analysis of scenarios for the Thematic Strategy*
  - *Macroeconomic modelling using the GEM-E3 model*
- See also European Commission website (http://www.europa.eu.int/comm/environment/air/cafe/index.htm) and IIASA RAINS model website (http://www.iiasa.ac.at/rains/)