Integrated Assessment with Monetary Valuation of Environmental Impacts

Rainer Friedrich

Universitaet Stuttgart

The 3rd International Conference on Eco-Efficiency

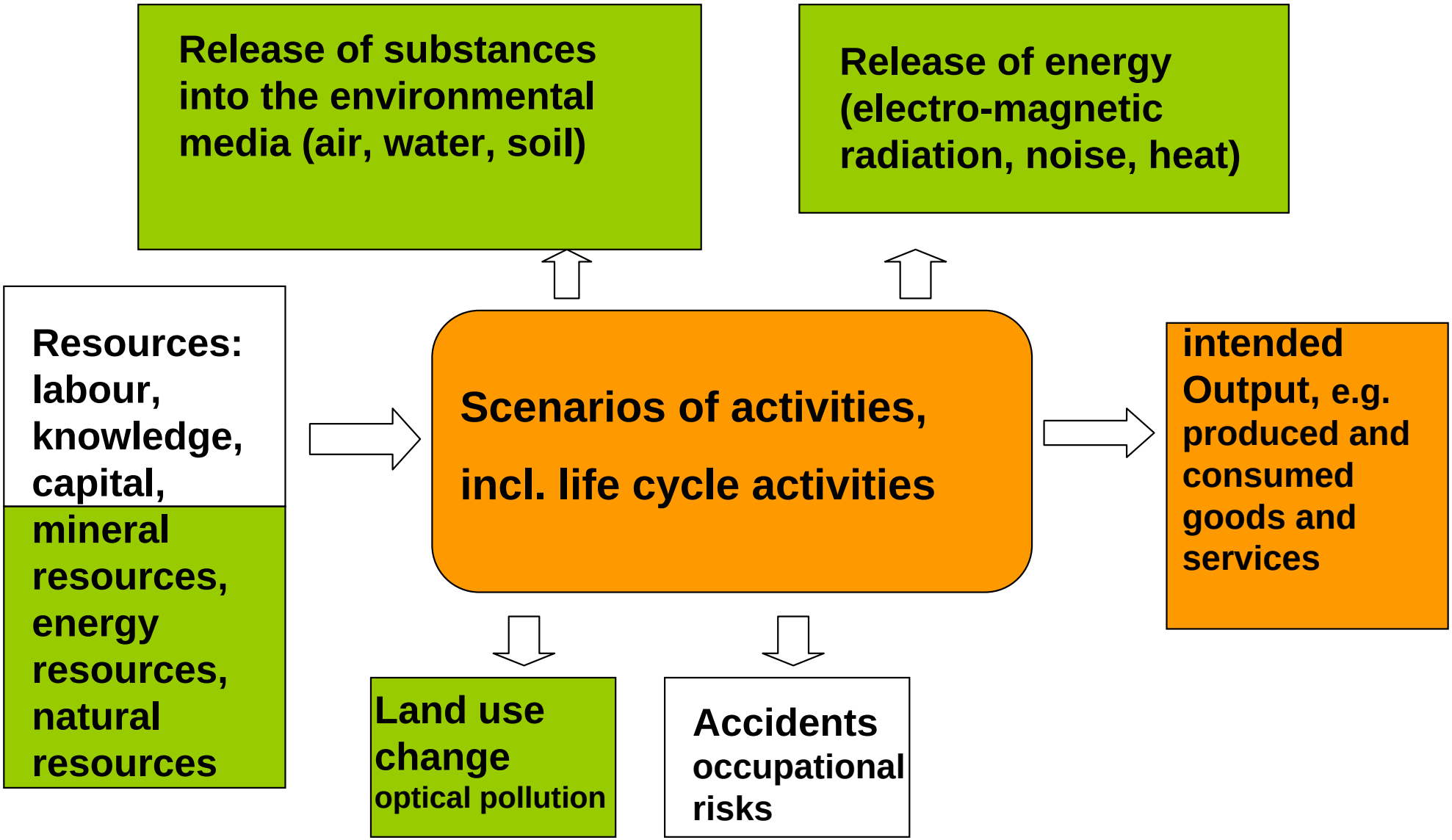
Modelling and Evaluation for Sustainability:
Guiding Eco-Innovation and Consumption

in Egmond aan Zee, Netherlands

9-11 June 2010

Use of the ‚ExternE' Methodology or Impact Pathway Approach

- **For assessing the environmental performance and thus eco-efficiency of current and future technologies**
- **For guiding the internalisation of externalities and thus stimulating eco-innovation**


Release of substances into the environmental media (air, water, soil)
Release of energy (electro-magnetic radiation, noise, heat)
Resources: labour, knowledge, capital,
mineral resources, energy resources, natural resources
Scenarios of activities,
incl. life cycle activities
intended Output, e.g. produced and consumed goods and services
Land use change
optical pollution
Accidents
occupational risks

Assessment of alternative technologies

-> If not all inputs and unintended outputs per unit produced decrease, no assessment can be made without weighting

-> non-monetary inputs and outputs (pressures, emissions), also the mid-points, can not be assessed/compared, only damages and benefits

-> thus it is necessary to estimate the damages and avoided damages caused by the pressures to the environment (to human health, flora and fauna/ecosystems, crops, materials)

-> damages depend on time and site of the release!

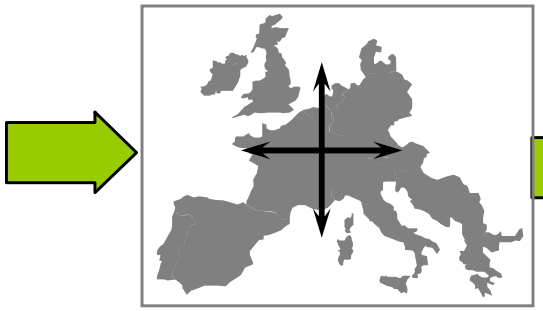
Impacts of air pollution from transport (years of life lost per 1000 t of emission) – country values

Pollutant emitted	NOx	NM VOC	SO2	PM2.5	PM2.5
Effective pollutant	O_3, Nitrates	O_3	Sulfates, Acid depos.	PM2.5	PM2.5
Local environment				urban	non-urban
Czech Republic	50	1	58	5 900	1 180
Finland	11	0,2	9	4 800	450
Belgium	57	1	81	6 200	1 470

Impact Pathway Approach, Step 1

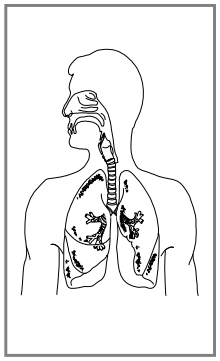
Pollutant/Noise Emission

Transport and Chemical Transformation in Air, Soil, Water, Food



Calculation is made twice: with and without project!

Differences of Physical Impacts



from scenarios of activities to pressures to damages

Impacts included (I)

Impact Category	Pollutant / Burden	Effects
Human Health – mortality	PM_{10}	Reduction in life expectancy due to short and long time exposure
	SO_2, O_3	Reduction in life expectancy due to short time exposure
	Benzene, BaP, 1,3-butad., Diesel part.	Reduction in life expectancy due to long time exposure
	Noise	Reduction in life expectancy due to long time exposure
	Accident risk	Fatality risk from traffic and workplace accidents
Human Health – morbidity	PM_{10}, O_3, SO_2	Respiratory hospital admissions
	PM_{10}, O_3	Restricted activity days
	PM_{10}, CO	Congestive heart failure
	Benzene, BaP, 1,3-butad., Diesel part.	Cancer risk (non-fatal)
	PM_{10}	Cerebrovascular hospital admissions, cases of chronic bronchitis, cases of chronic cough in children, cough in asthmatics, lower respiratory symptoms
	O_3	Asthma attacks, symptom days
	Noise	Myocardial infarction, angina pectoris, hypertension, sleep disturbance
	Accident risk	Risk of injuries from traffic and workplace accidents

Impacts included (II)

Impact Category	Pollutant / Burden	Effects
Building Material	SO_2, Acid deposition	Ageing of galvanised steel, limestone, mortar, sand-stone, paint, rendering, and zinc for utilitarian buildings
	Combustion particles	Soiling of buildings
Crops	SO_2	Yield change for wheat, barley, rye, oats, potato, sugar beet
	O_3	Yield change for wheat, barley, rye, oats, potato, rice, tobacco, sunflower seed
	Acid deposition	Increased need for liming
	N, S	Fertilising effects
Global Warming	CO_2, CH_4, N_2O, N, S	World-wide effects on mortality, morbidity, coastal impacts, agriculture, energy demand, and economic impacts due to temperature change and sea level rise
Amenity losses	Noise	Amenity losses due to noise exposure
Ecosystems	Acid deposition, nitrogen deposition	Acidity and eutrophication (avoidance costs for reducing areas where critical loads are exceeded)

Assessment of Damages

- **Step 1: the exceedance of essential thresholds should be avoided at any costs, safe minimum standards should be kept.**

- **Step 2: Assessment of impacts is based on the (measured) preferences of the affected well-informed population**

This implies:

Available information should be explained before measuring preferences

Benefit transfer of unit values e.g. with income adjustments

Increase of monetary values with time: income elasticity of 0.7-1.0

Weighting factors are expressed as monetary values **(e.g. €2010)** :

Not absolutely necessary, but has advantages:

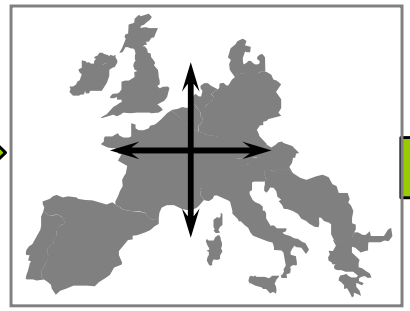
->allows transfer of values, units are conceivable, direct use of results in CBA and for internalising via taxes possible

- ***-> however: 'utility points' would give the same results***

Impact Pathway Approach with ECOSENSE

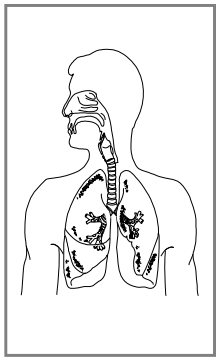
Pollutant/Noise Emission

Transport and Chemical Transformation in Air, Soil, Water, Food



Calculation is made twice: with and without project!

Differences of Physical Impacts



Monetary Valuation

Valuation methods for non-market goods

Revealed Preference (RP)
behaviour (shown in the past)

Stated Preference (SP)
surveys (about future behaviour)

Indirect valuation

assesses costs or efforts that can be linked to the non-market good

- **Hedonic Price Method**
- **Averting Behavior Method (including past decisions about abatement policies)**
- **Travel Cost Method**
- **Contingent Behavior Method**

Direct valuation

- **Contingent Valuation Method (CVM)**
- **Attribute Based Choice Modeling (ABCM)**
- **Participatory approaches**
- **Surveys for preferences of public decision makers**

Monetary Valuation: recommended central values for the EU

Health end-points	Euro per case / per YOLL
Increased mortality risk (infants)	3,000,000
New cases of chronic bronchitis	200,000
Increased mortality risk - YOLLacute	60,000
Life expectancy reduction - YOLLchronic	40,000
Respiratory hospital admissions	2,000
Cardiac hospital admissions	2,000
Work loss days (WLD)	295
netto Restricted activity days (netRADs)	130
Minor restricted activity days (MRAD)	38
Lower respiratory symptoms	38
LRS excluding cough	38
Cough days	38
Medication use / bronchodilator use	1

Weaknesses?

As yet not all substances included in detailed analysis:
screening using LCIA methods (e.g. PDF and YOLL);

Treatment of Damocles Risks:
Step 1 assessment and Swiss approach (factor 200 for probability lower 1:1000)?

Inclusion of precautionary principle:
Standard price approach

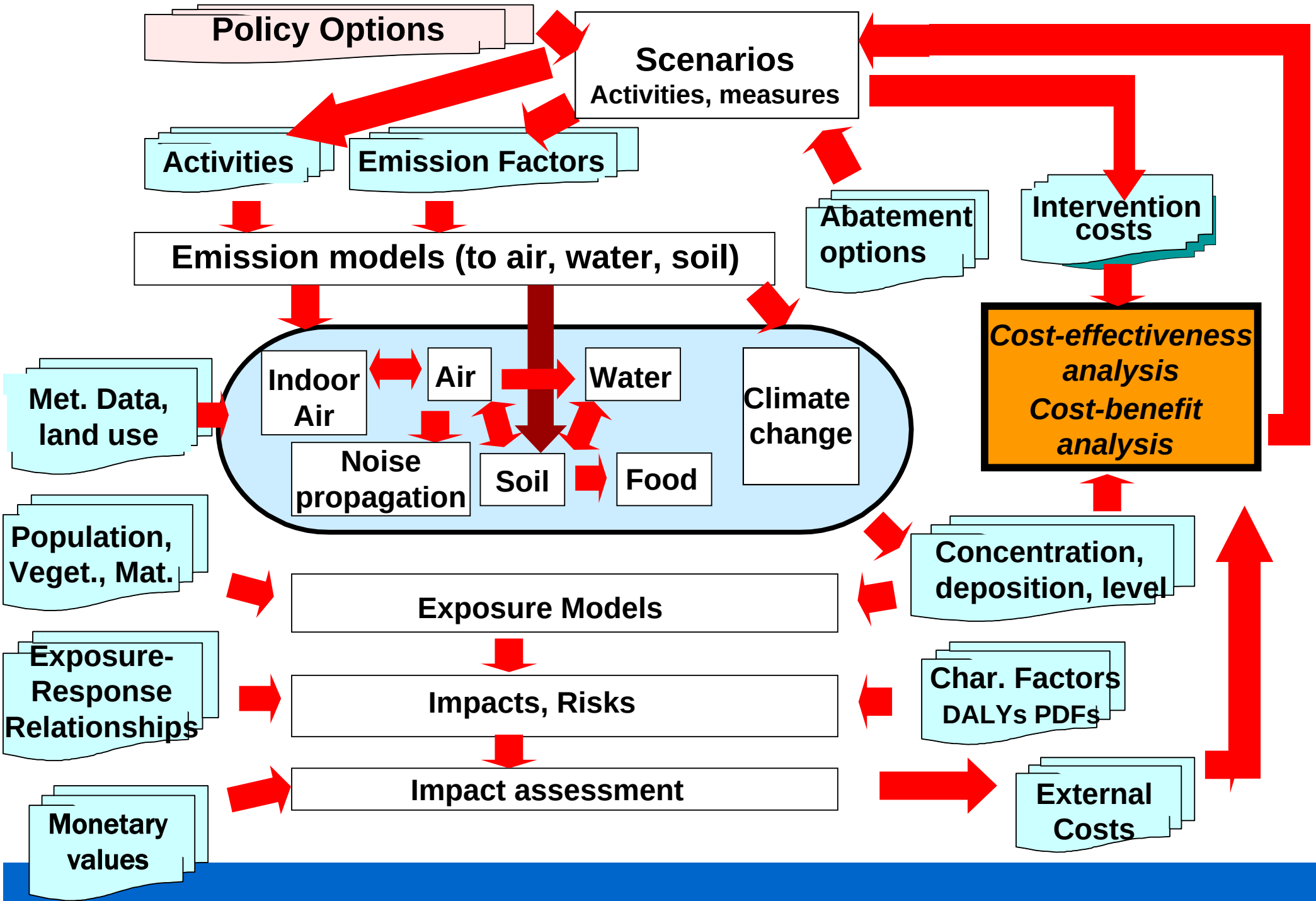
Treatment of resource depletion:
Sensitivity with reduced discount rate

Use of contingent valuation for assessing monetary values sometimes problematic:
-> use of other methods (choice modelling, participatory approaches)

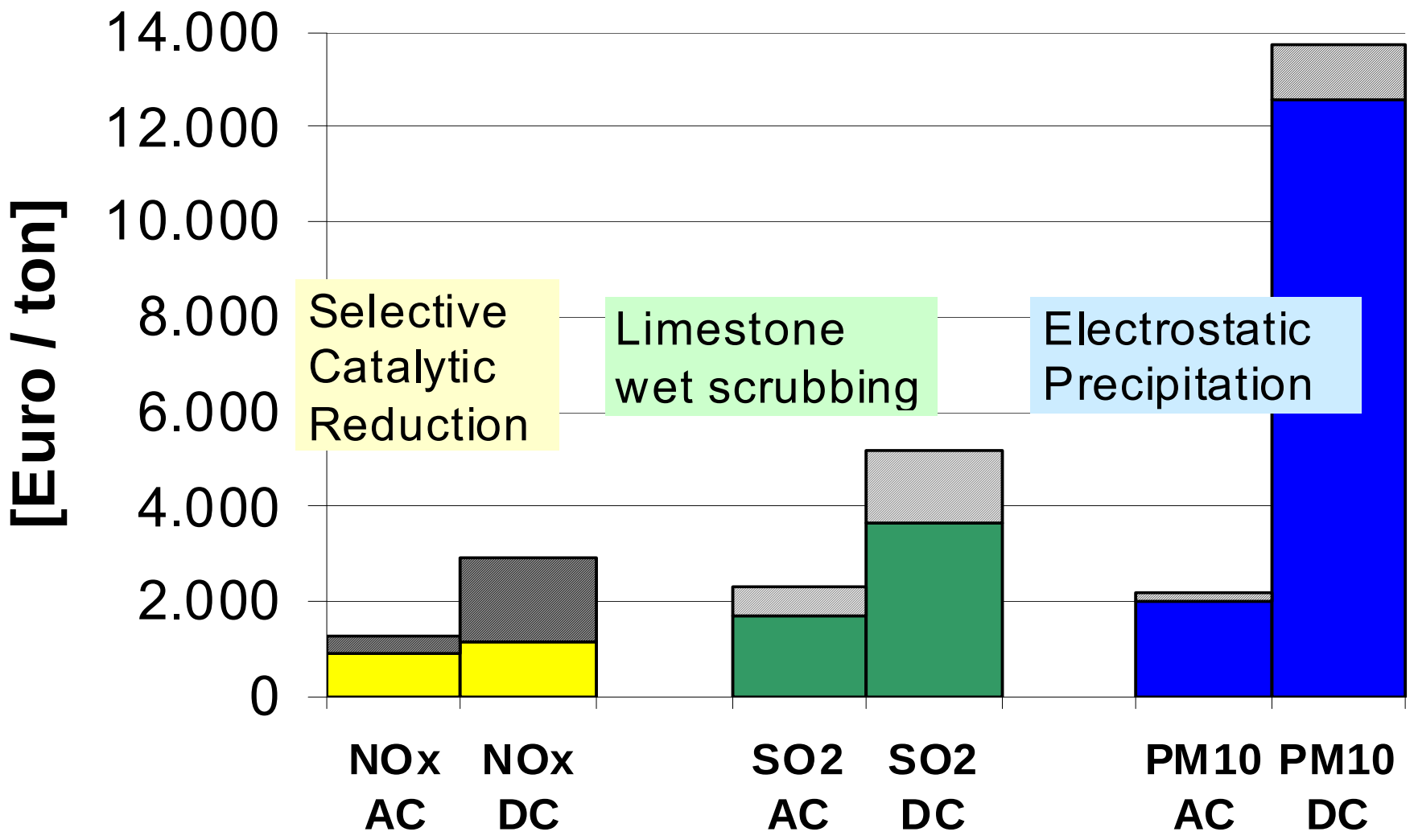
Distributional effects:
(partly) calculated, but not monetized

Large uncertainties:
Reflects uncertainty of knowledge -> sensitivity analysis; political decision

The Integrated Modelling System ECOSENSE



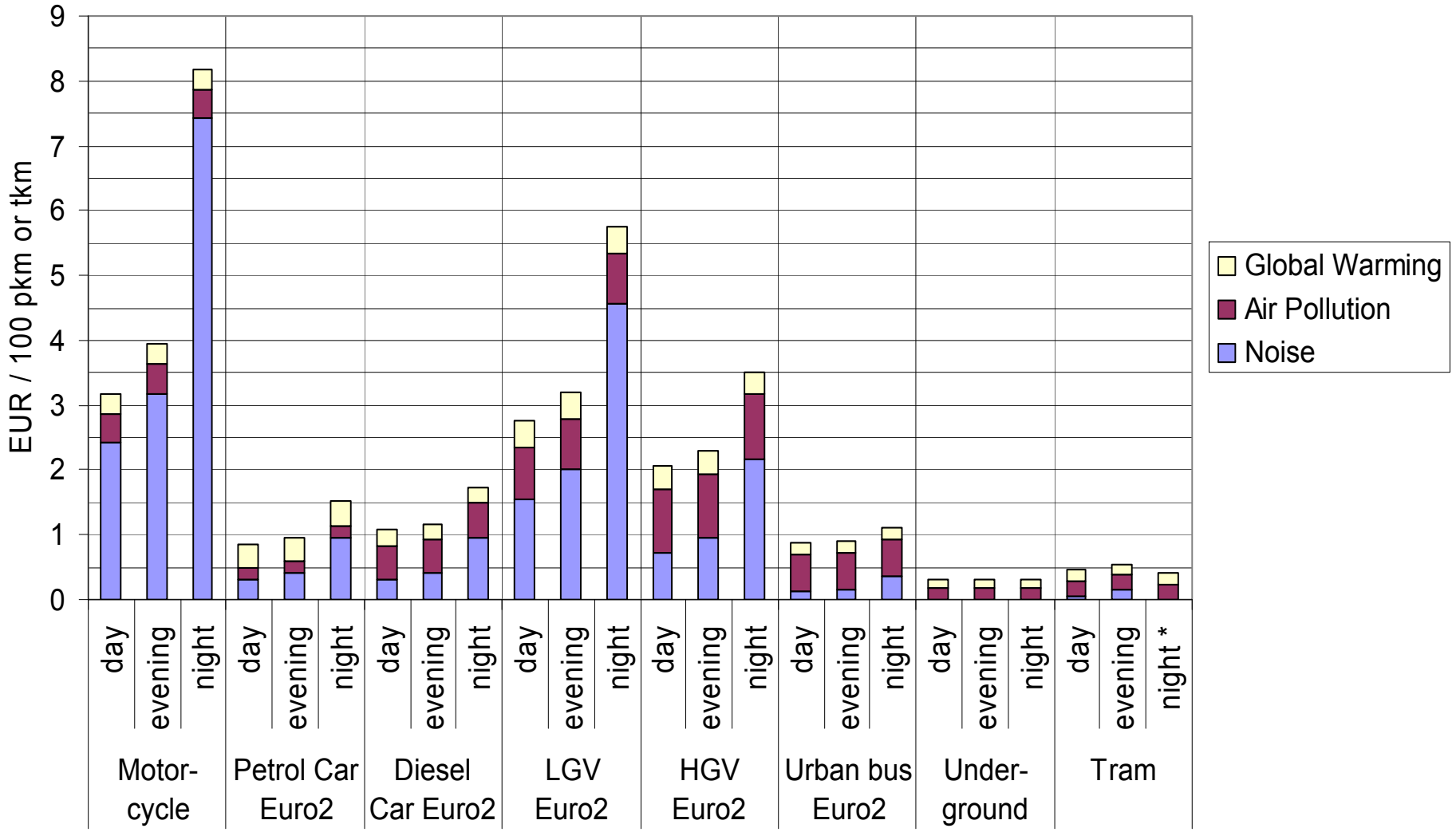
Cost-Benefit-Analysis: Abatement and Damage Costs



AC = Abatement Costs, lower and upper value

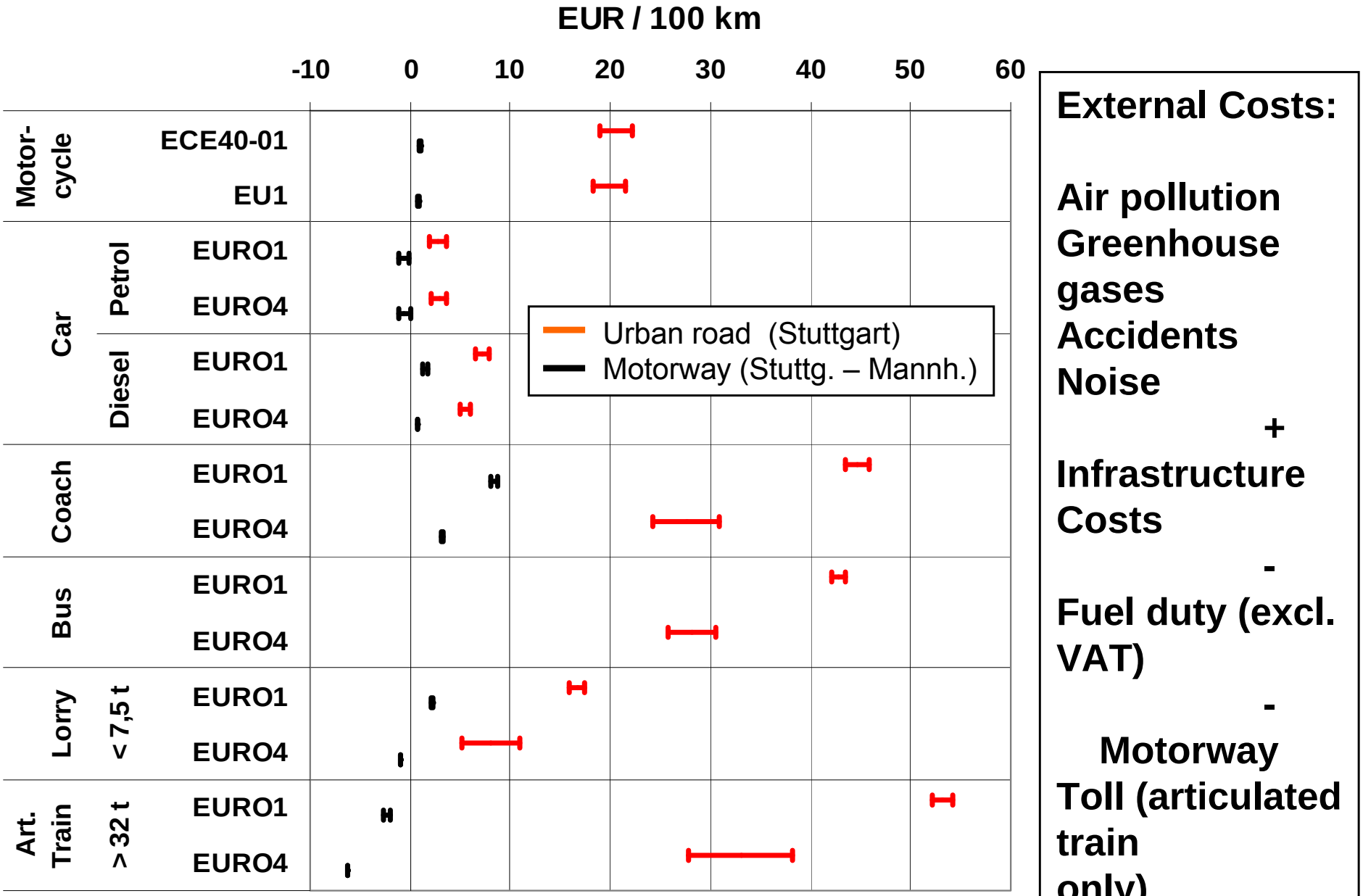
DC = Damage Costs - lower value for UK, upper for Germany

Marginal costs due to urban transport in Berlin



* no night time noise available

Comparison of Variable Costs and Revenues Road Transport DE



External Costs:

Air pollution
Greenhouse gases
Accidents
Noise

+

Infrastructure Costs

-

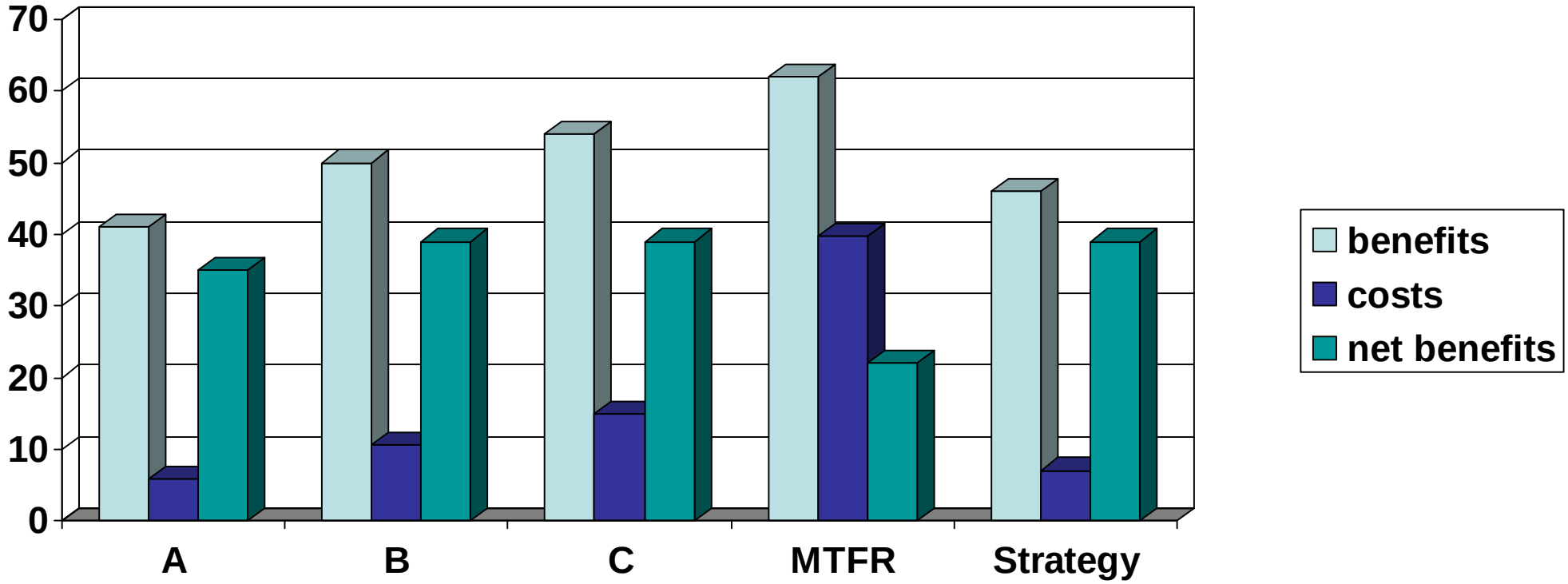
Fuel duty (excl. VAT)

-

Motorway Toll (articulated train only)

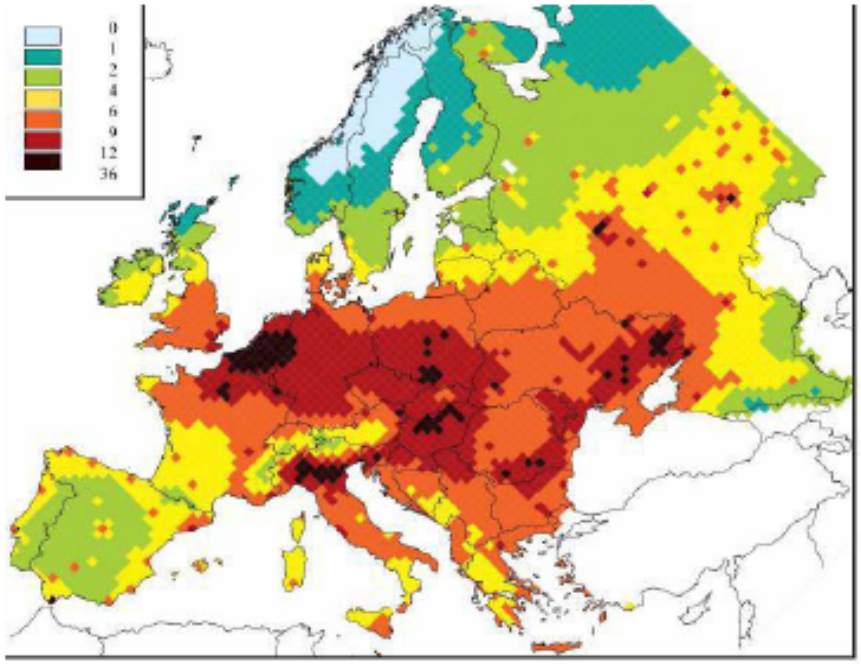
CAFE (Clean Air for Europe) – Cost-Benefit Analysis to Support the Development of the New Air Quality Directive

Comparison of annualised costs and benefits for the EU25 under the different scenarios relative to the CLE baseline (€million/year).

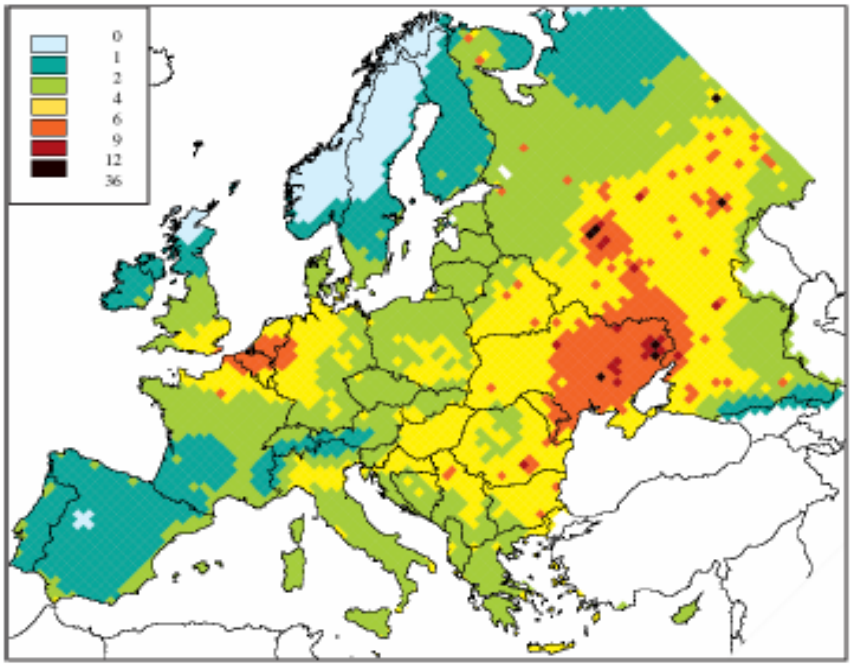


Thematic Strategy – changes in loss of life expectancy

Changes in loss of life expectancy in the EU in 2000 and in the interim objective in 2020 (Strategy)



2000



Strategy in 2020

Summary

A methodology for integrated environmental assessment (the ExternE/INTARESE methodology) has been developed, which assesses the impacts of air pollution, climate change, noise, exposure to heavy metals and POPs (pesticides, dioxins, furans) via ingestion and inhalation, eutrophication, acidification and land use change. This list is constantly expanded; it can be used to measure eco-efficiency. The methodology is already widely used for policy support in the EU.

- **More information: www.externe.info; heatco.ier.uni-stuttgart.de; (transport) www.integrated-assessment.eu (from October 2010)**