The Costs of Environmental Pollution

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Scoping: Which pollutants are relevant?

Pollutant	DALYs
PPM2.5	373 831
SO_2	358 810
NO_x	330 304
NH_3	167 690
NMVOC	26 803
B-a-P	9 581
Hg	4 649
CO	3 523
Dioxins	3 412
As	2 645
PPM_{coarse}	2 477
Cd	181
Zn	175
PAHs	156
Cr	51
Se	38
Ni	35
HCB	5

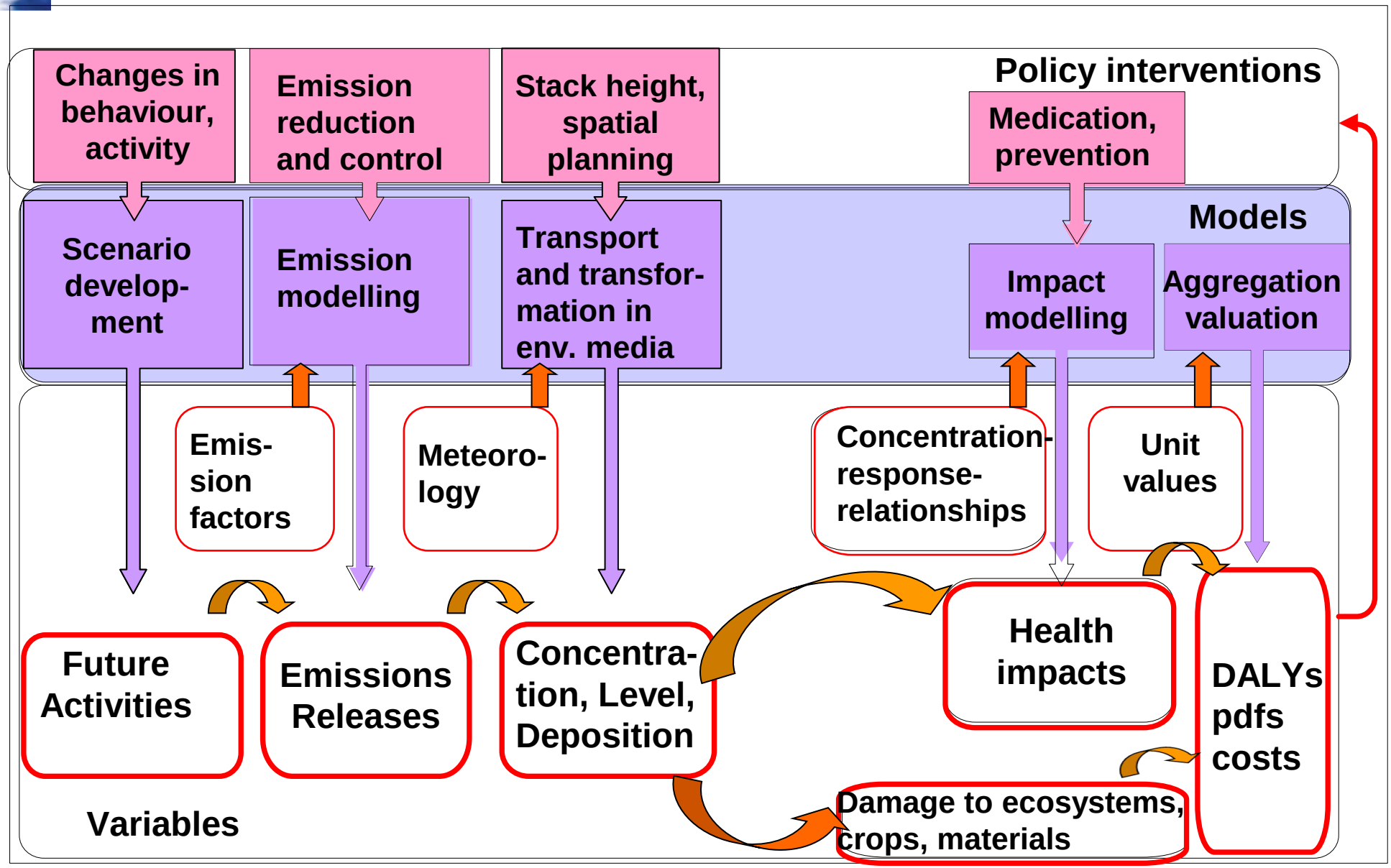
PPM2.5, NO_x, SO_2 and NH_3 cause ca. 88% of total environmental and health damage

Estimation of DALYs (disability adjusted life years) caused by environmental pollution in Germany 2000

Methodology - principles

- Impacts (damage, risks) caused by pressures have to be estimated.
- Impacts depend on time and site of the activity
- Impacts and benefits are expressed in monetary units
- Assessment of impacts is based on the preferences of the affected well-informed population

Methodology: the impact pathway approach



New developments after ExternE and NEEDS

e.g. HEIMTSA, INTARESE, EXIOPOL, LC-Impact, TRANSPHORM, HEALS, ICARUS

1 calculation of the urban increment (PM2.5, PM10, NO2)

$$C_{i\ urban} = \varpi_i + \phi_i \frac{E_{iUE}}{A_{UE} \cdot u_{avg}} + \gamma\, C_{i\ rural}$$

where
C_i urban = Urban increment of pollutant i.
E_{iUE} = Total emission of pollutant i within the urban entity in tons.
A_{UE} = Urban entity area in km².
u_{avg} = Urban entity average wind speed in m/s.
$C_{i\ rural}$ = Rural background concentration of pollutant i in µg/m³
ω_i, φ_i, and γ_i = Multiple-regression parameters for pollutant i.

New developments after ExternE and NEEDS

e.g. HEIMTSA, INTARESE, EXIOPOL, LC-Impact, TRANSPHORM, HEALS, ICARUS

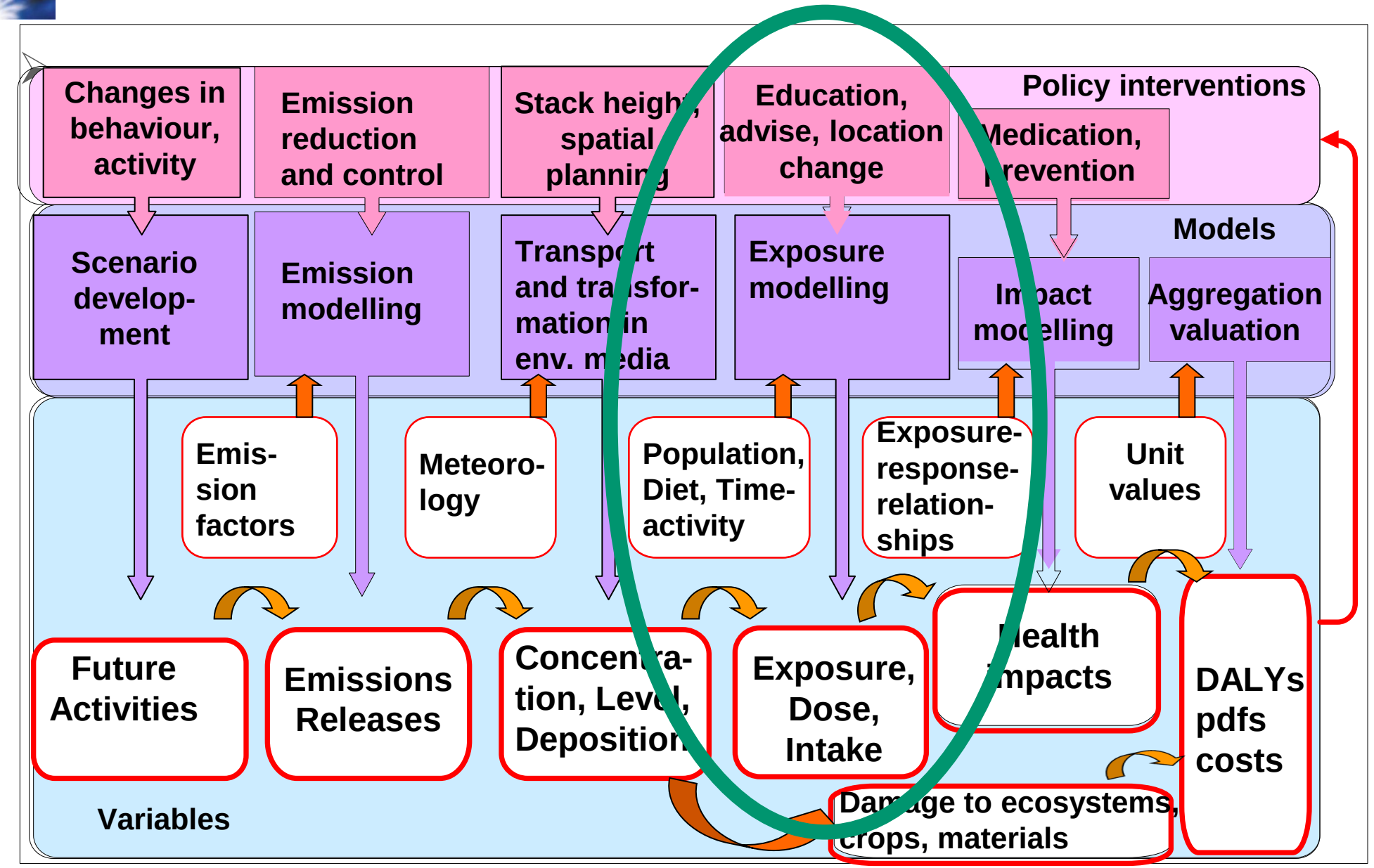
2) New concentration response relationships from WHO study

WHO 2013: Health risks of air pollution in Europe – HRAPIE project: 'Recommendations for concentration-response functions for cost-benefit analysis of particulate matter, ozone and nitrogen dioxide

Pollutant	Relative Risk (95% C.I.) All cause natural mortality >30 years
PM2.5 (per 10 µg/m3)	1.062 (1.04-1.083)
NO2 (per 10 µg/m3) above 20 µg/m3	1,055 (1,03-1,080) up to 33% overlap

For the first time:
Relationship between annual average NO2 and mortality and between NO2 24h average and hospital admissions

3 New element: exposure modelling incl. indoor modelling

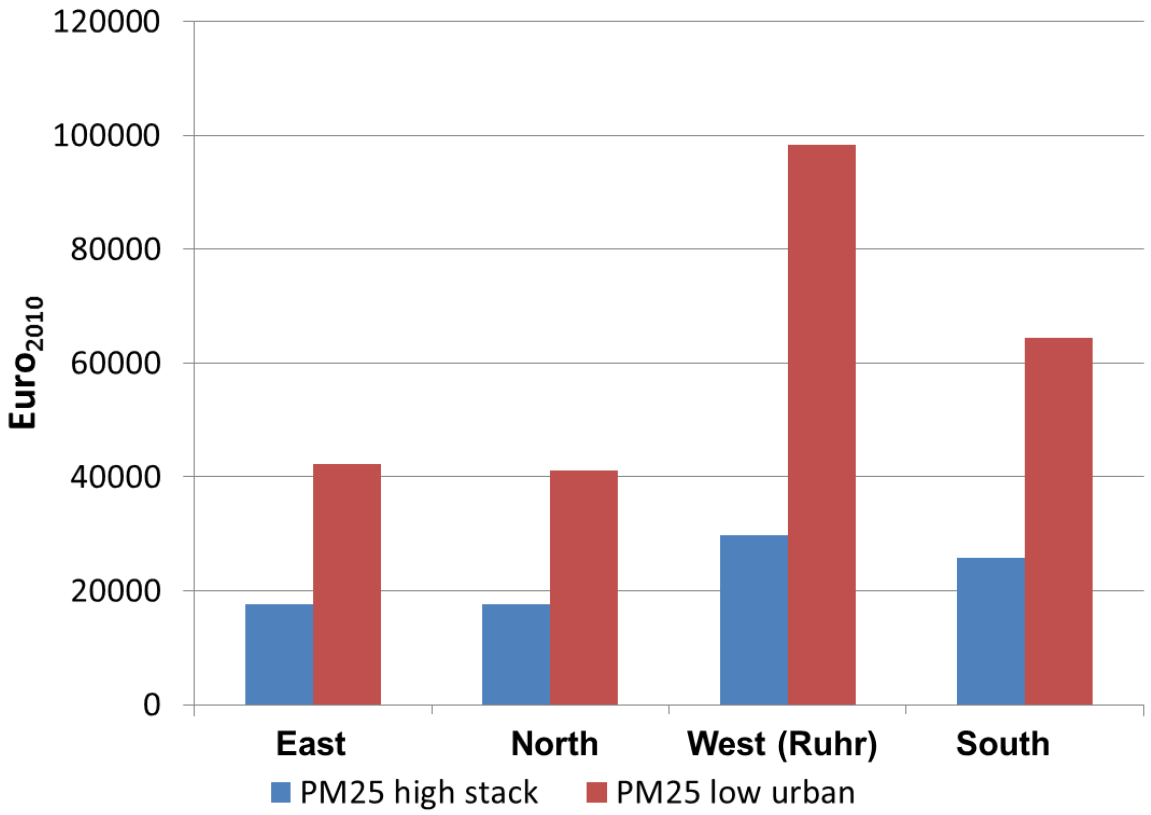


A shortcut to results: provision of unit values

Impacts and external costs per kg of pollutant released to air, water, soil differentiated according to

- **pollutant,**
- **height of release (high stack, medium, street level)**
- **country or subregion (in larger countries) in Europe, larger countries or regions in the rest of the world**
- **agglomeration, urban, rural environment.**

Damage costs per tonne of PM2.5 emitted for different regions in Germany and different release heights



Assessment of Uncertainty

Statistical analysis:

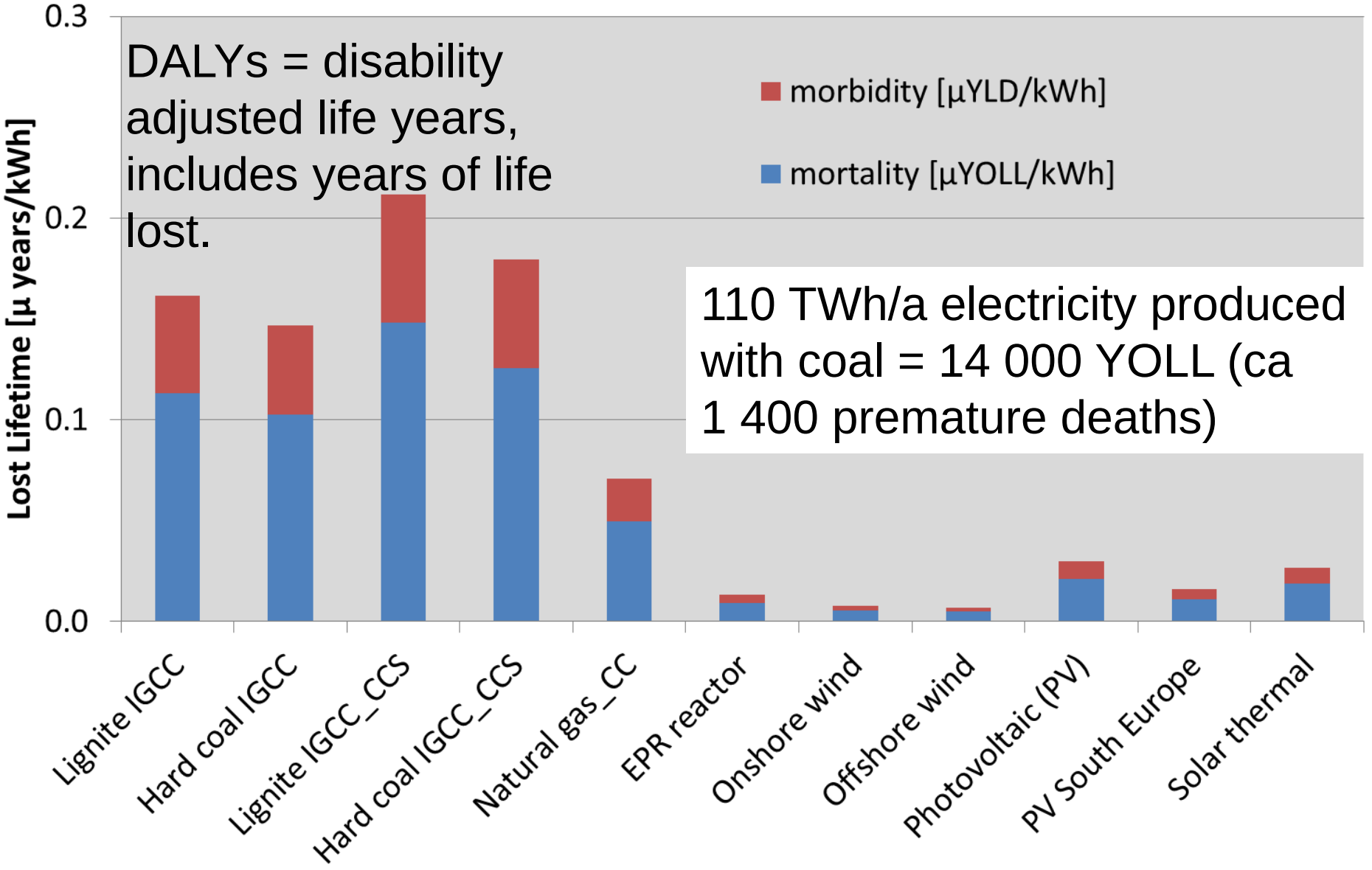
1 geometric standard deviation for mortality

caused by primary PM2.5: $\sigma_g = 2,1$

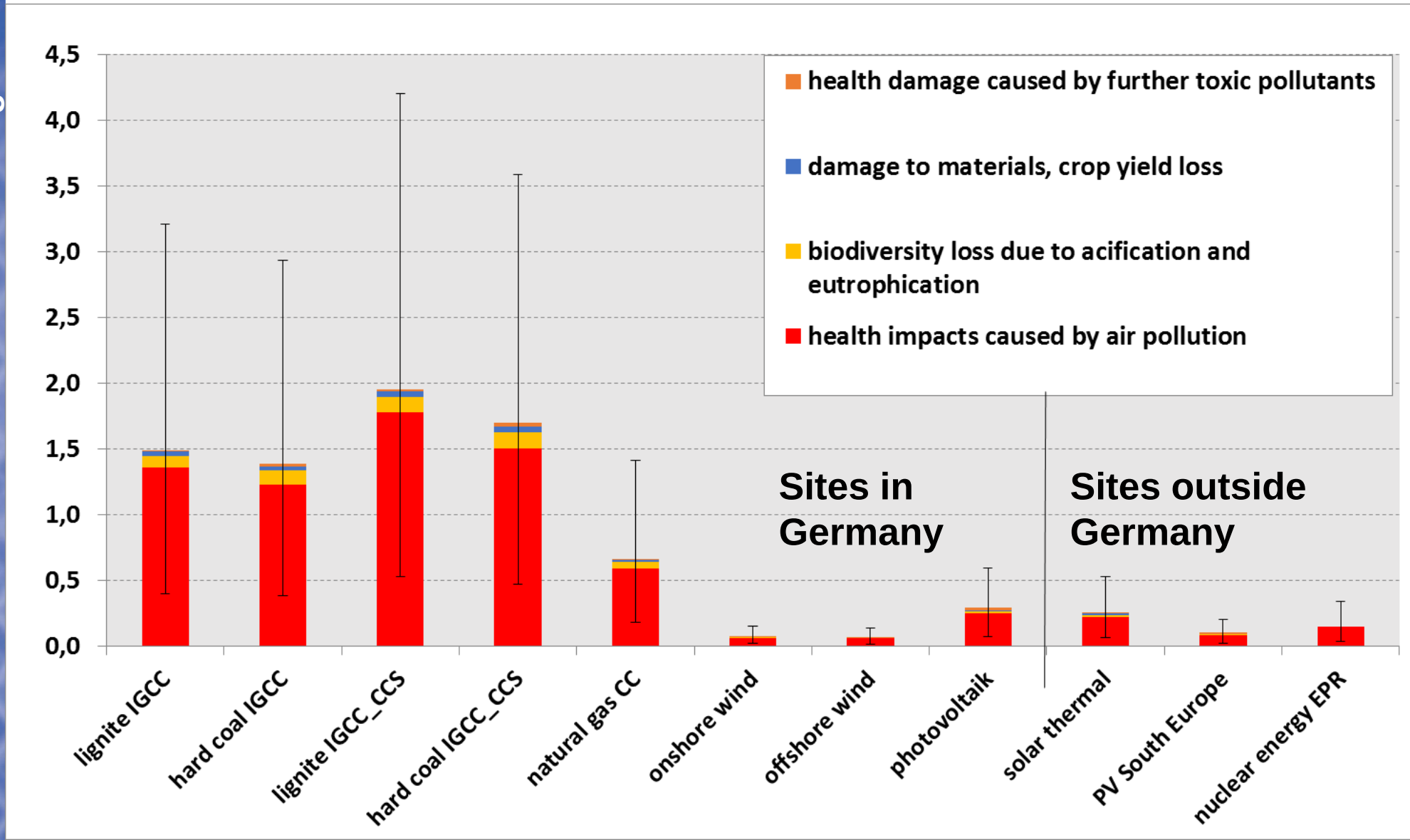
caused by sulfates: $\sigma_g = 2,4$

caused by nitrates: $\sigma_g = 2,5$

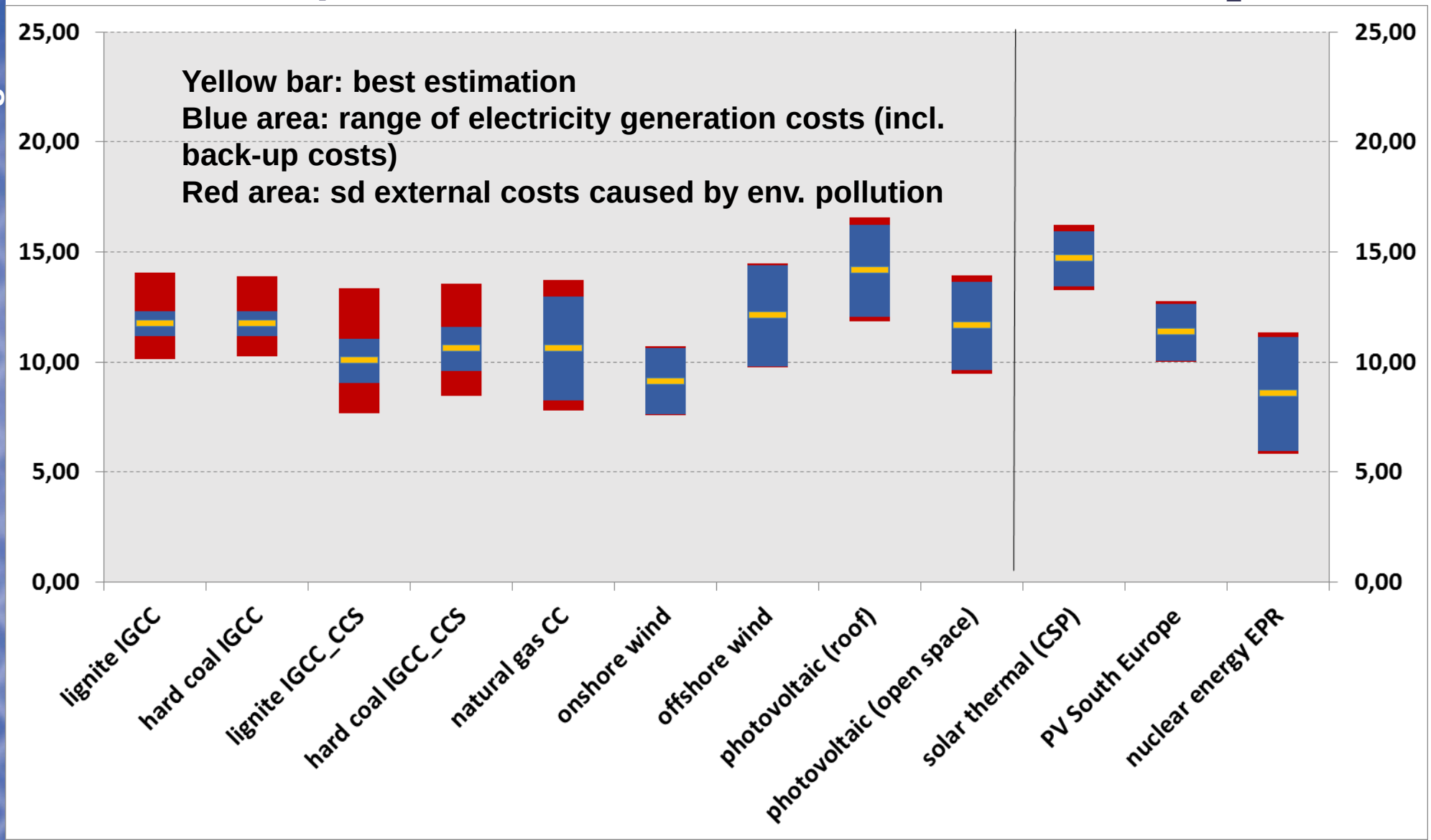
Risks to human health per kWh [DALYs per kWh]



External costs caused by pollutants released by new power plants, initial operation 2025, direct NO_2 impacts not included



Social (= full) costs of electricity generation, initial operation 2025, 2°max Scenario (74 €/t CO_2)



Summary

Methodology – the impact pathway approach – and tools – ECOSENSE - available to estimate the costs of environmental pollution.

Methodology is widely used to support decision making, e.g. for assessing environmental policies and transport projects

more information:

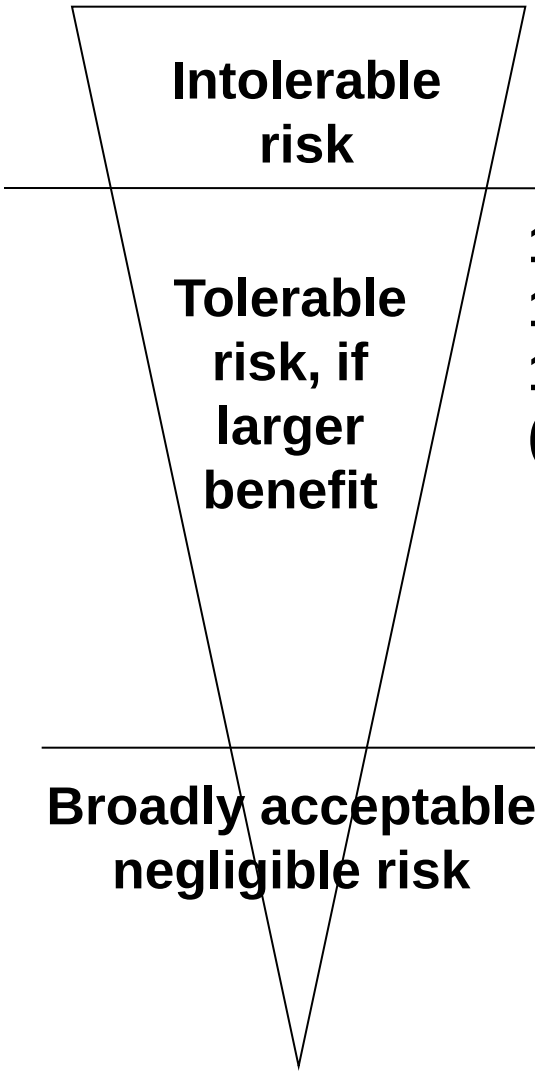
www.externe.info

www.integrated-assessment.eu

VLVL vs. VSL

1) only small risks are assessed (not a human life, but a small risk to loose the life or die prematurely)
2) Monetary values represent the average willingness to pay to avoid a small risk (no distinction according to age a.s.o.)
3) For immidiate death (accidents) VSL is a correct indicator, as for all events the average life time lost is the same.
4) For air pollution impacts, a life time exposure leads – with a certain frequency in the exposed population – to illness, which gets chronic and finally leads to premature death. An additional exposure may lead to an increase in the frequency of developing illness and may also increase the life time lost of those affected.
5) The relevant question would be: what would you be willing to pay now to avoid a reduction of life expectancy (which would only occur later, i.e. at the end of your life)? Would the WTP be the same for a reduction of your life expectancy by 1 day and for a reduction of 1 year? Or: Would you pay more for avoiding a risk to die immideately than for a risk to loose a year at the end of your life with the same probability?

VLYL vs. VSL: Assessment is made of small risks



Individual risks:

10^{-5} /a (HSE UK);
10^{-4} /a (AGS)
$10^{-5/-6}$ /a (Netherlands)

AGS = Ausschuss für Gefahrstoffe,
HSE = Health and Safety Executive

Step 1: Inacceptable intolerable risks have to be avoided by all means (e.g. via thresholds, bans).

Step 2: The assessment of tolerable risks is based on the measured preference of the affected well informed population.