The Extended Impact Pathway Approach - New Generalised Results for use in Life Cycle Impact Assessment, Integrated Projects and Optimisation Models

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Presentation Outline

- Aims and principles of Impact Pathway Approach (IPA)
- the Impact Pathway Approach
- Important air pollutants considered
- Example for impact assessment – “from emission to external costs”
- Country specific generic results per tonne of pollutant
- Application of generalised results to electricity technologies
- Summary

Aim of the methodology:
➔ helps to take into account all externalities in a consistent way when making decisions

- ✓ ***Investment decisions***
- ✓ ***Technology Assessment (subsidies, research support)***
- ✓ ***Consumer decisions (e.g. by adjusting prices, by internalisation of external costs)***
- ✓ ***Cost-benefit analyses, esp. for environmental and health regulation***
- ✓ ***Green accounting***

Basic principles

1) **Pressures, e.g. emissions of substances to environmental media) have to be estimated**

2) **Assessment of effects/impacts (e.g. health risk), of the pressures**

→ **relation between pressure and impact is in general not linear and**

→ **impacts depend on time and location of pressure**

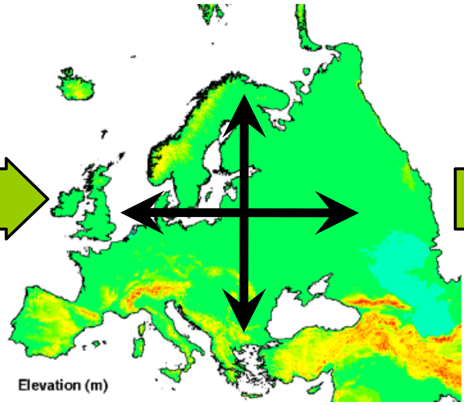
➔ ***"Bottom-up approach" needed to account for the complex pathways:***

***the 'Impact Pathway Approach'* (IPA)**

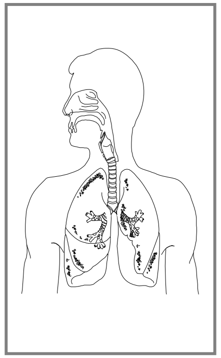
Impact Pathway Approach (IPA) – first part

Emission

Transport and Chemical Transformation



Damage



From dust, SO_2, NH_3, NO_x & NMVOC emission to air **via** dispersion and chemical transformation **to** concentration and deposition of:

Fine primary particles with diameter below 2.5 µm (PPM2.5)
Coarse primary particles with diameter between 2.5 and 10 µm (PPMco)
Secondary **I**norganic **A**erosols (SIA) - ammonium nitrate and sulphate particles
Dry and wet deposition of oxidized and reduced nitrogen
Dry and wet deposition of sulphur
Ozone (SOMO35: sum over means of 35 ppb)

Other substances also included: important heavy metals, POPs, greenhouse gases, dioxins, radio nuclides as well as other pathways.

Quantification of Impacts and Costs

relation between pressure and impact

Concentration Response Function (CRF):

Example: Additional **Y**ears **of** **L**ife **L**ost

= 6.5 · 10^{-5} · Δconc. PPM2.5 ·*Population*

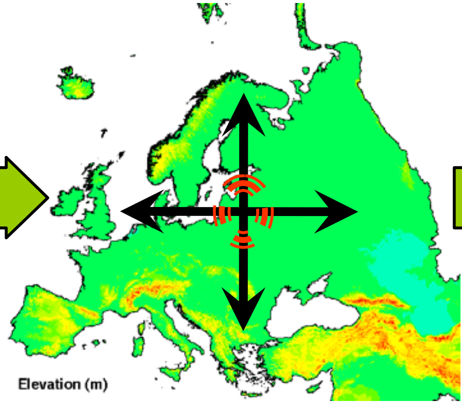
Number of Years of Life Lost [YOLL] due to 1 tonne of fine dust PPM2.5 emitted at a location in Europe leads to a range of ca.

0.01 to up to 15 life years lost.

Impact Pathway Approach → **Weighting and Aggregation**

Emission

Transport and Chemical Transformation



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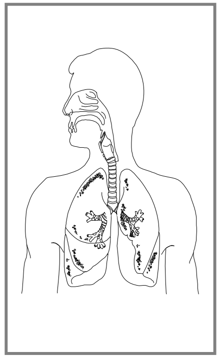


Monetary Evaluation

Basic principles -
Part 2: Quantification of Costs

Preferences of society are expressed, and

effects are transformed into monetary units:

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

(…however, e.g. 'utility points' would give the same ranking).

Monetary Valuation

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

Quantification of Costs

Monetary value: 40,000 Euro per Year of Life Lost

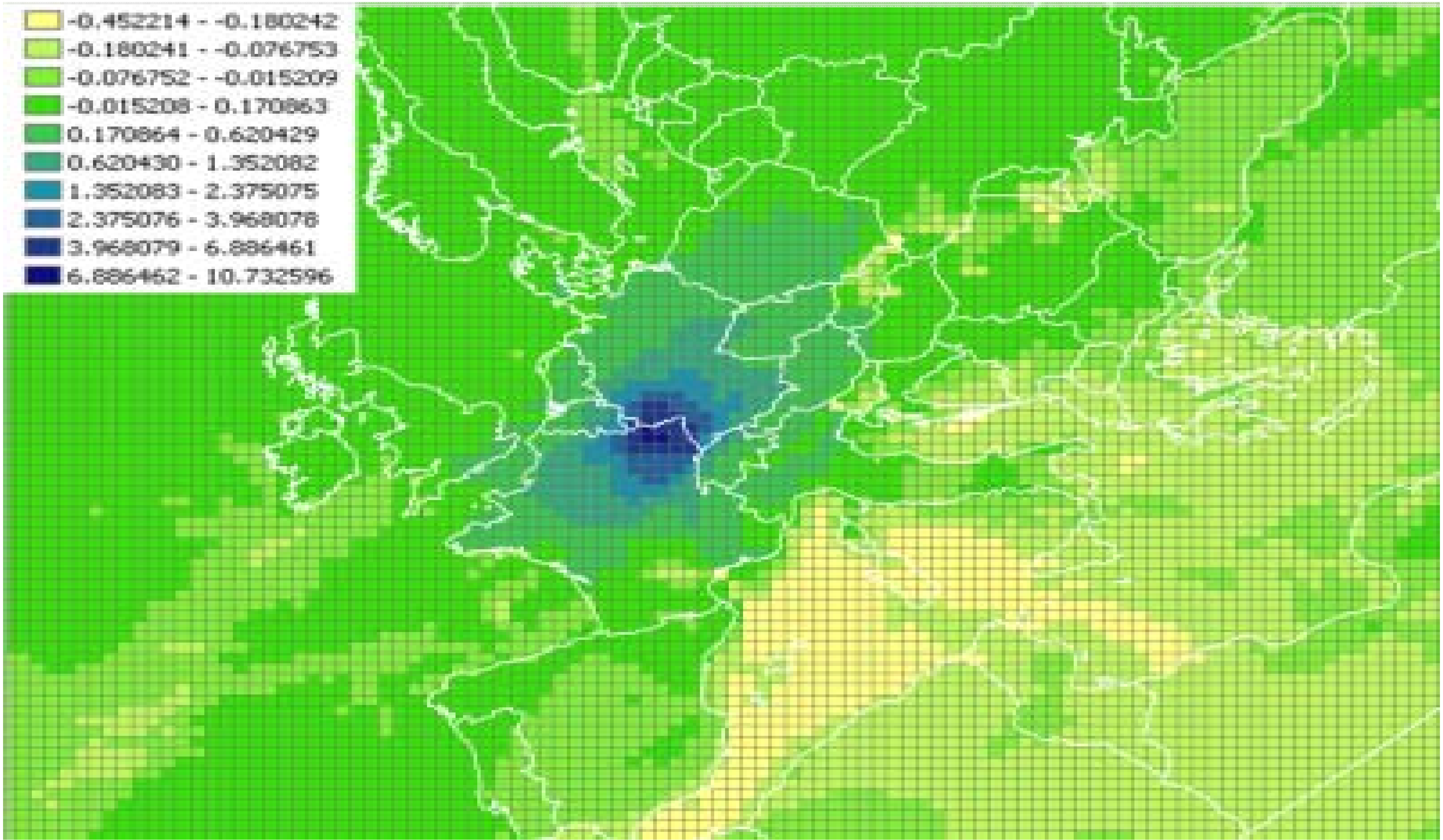
Damage costs :

0.5 YOLL per tonne PPM2.5 * 40,000 Euro per YOLL

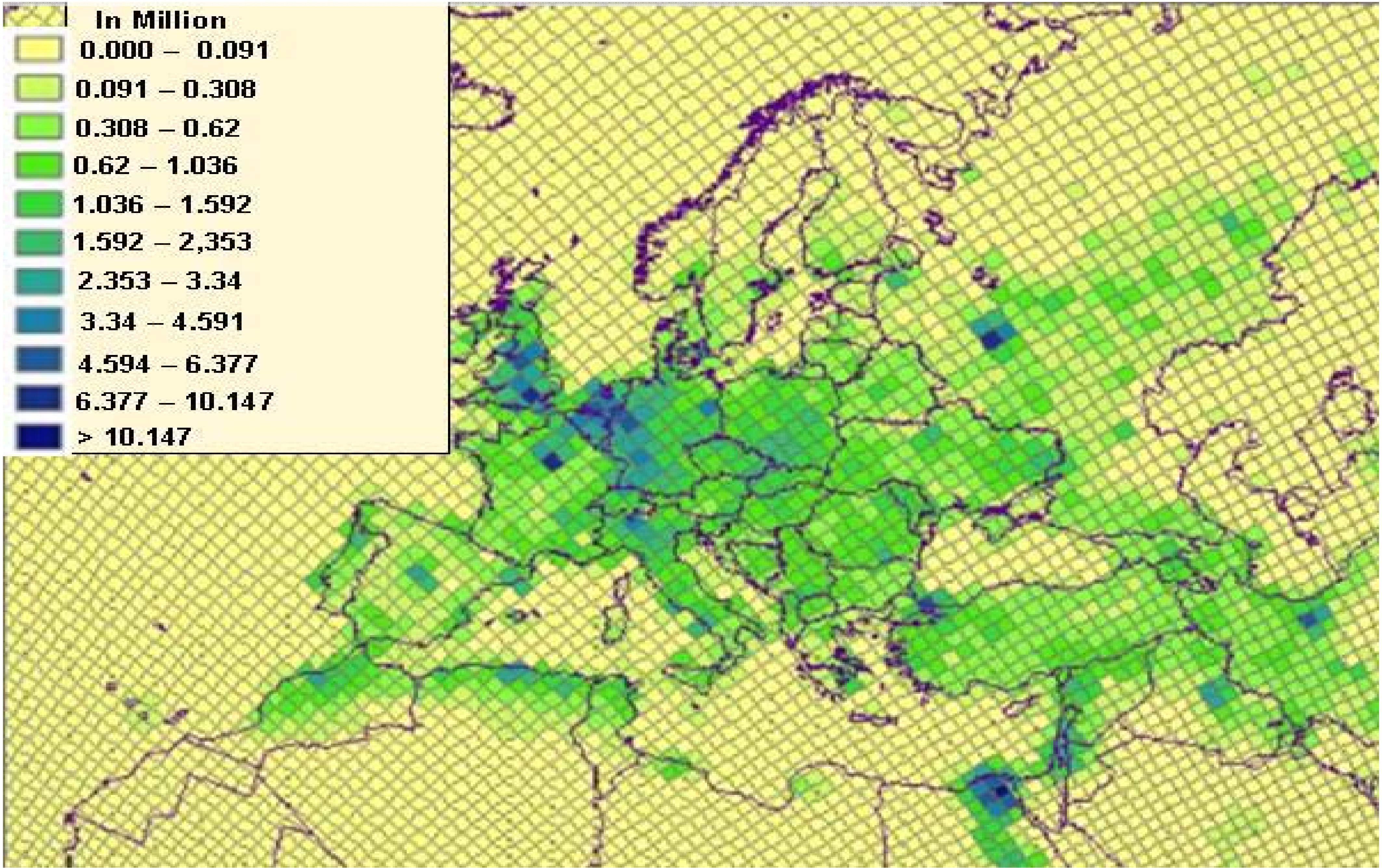
= 20,000 Euro per tonne PPM2.5

… but other air pollutants?

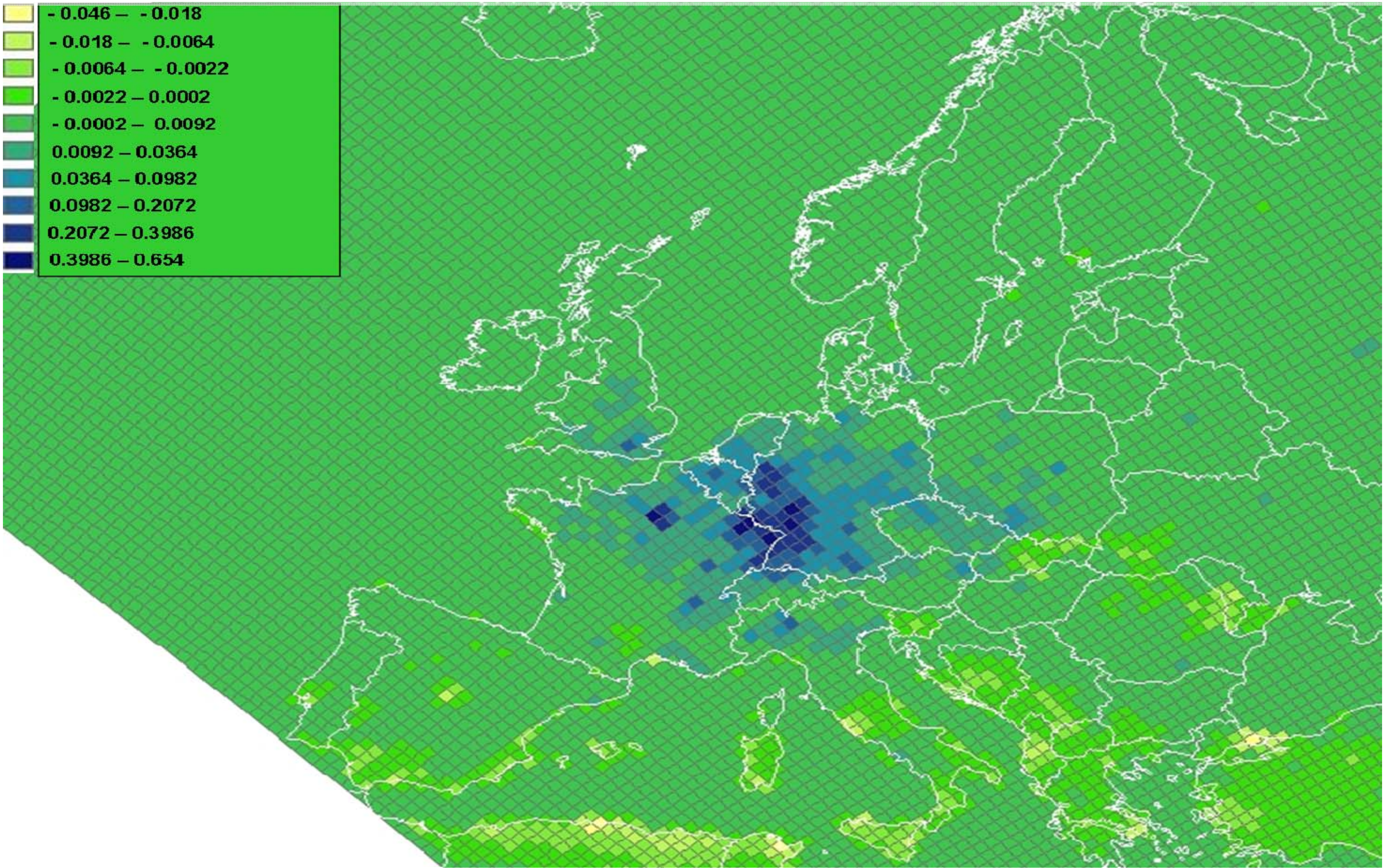
Concentration change of ozone [µg/m³] due to emission of 1 tonne NOx in a sub-region of Germany



Population Distribution

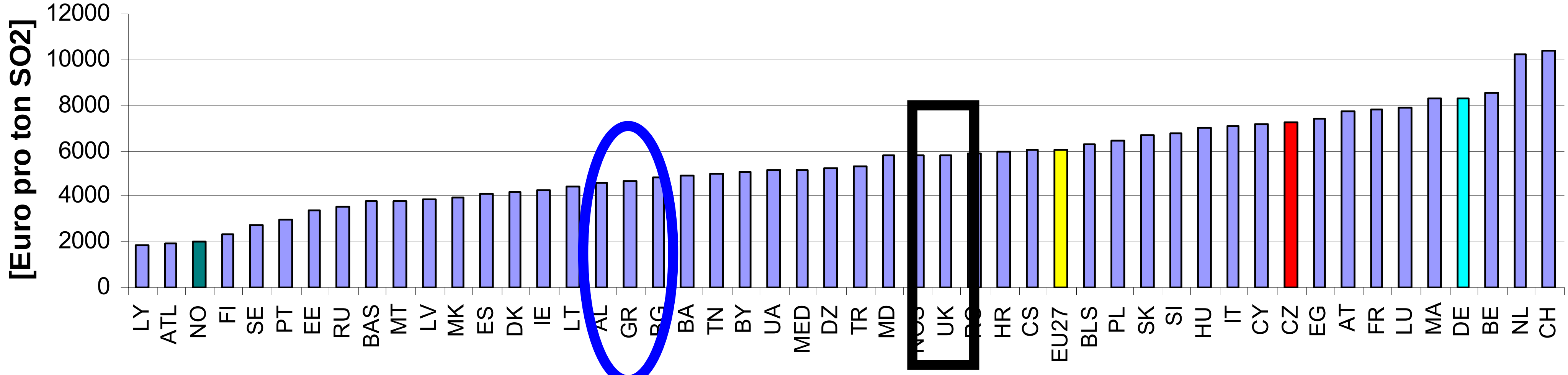


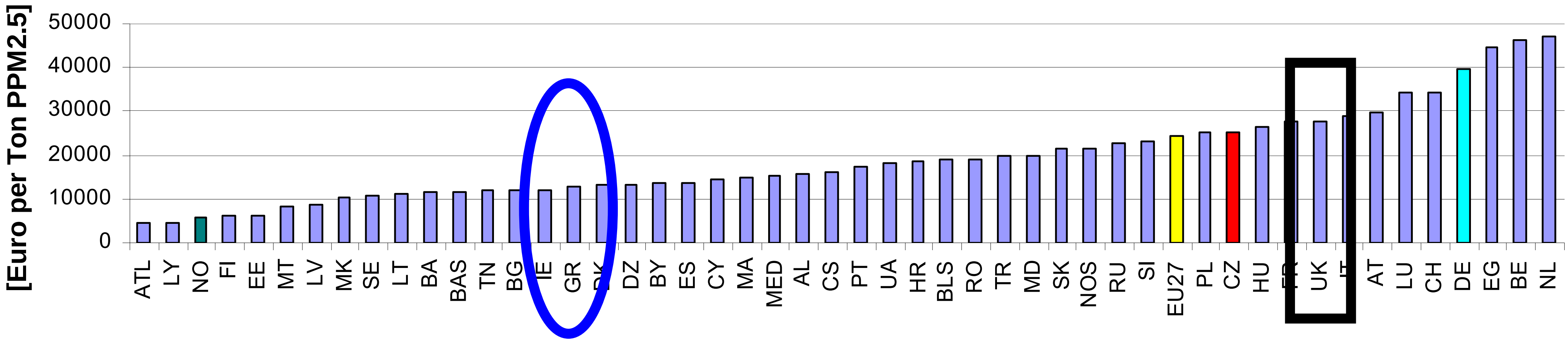
Population * Delta Conc.* CRF → numb. of life years lost



Aggregated Results [Euro per tonne] per country→ Example SO_2 and $PPM_{2.5}$

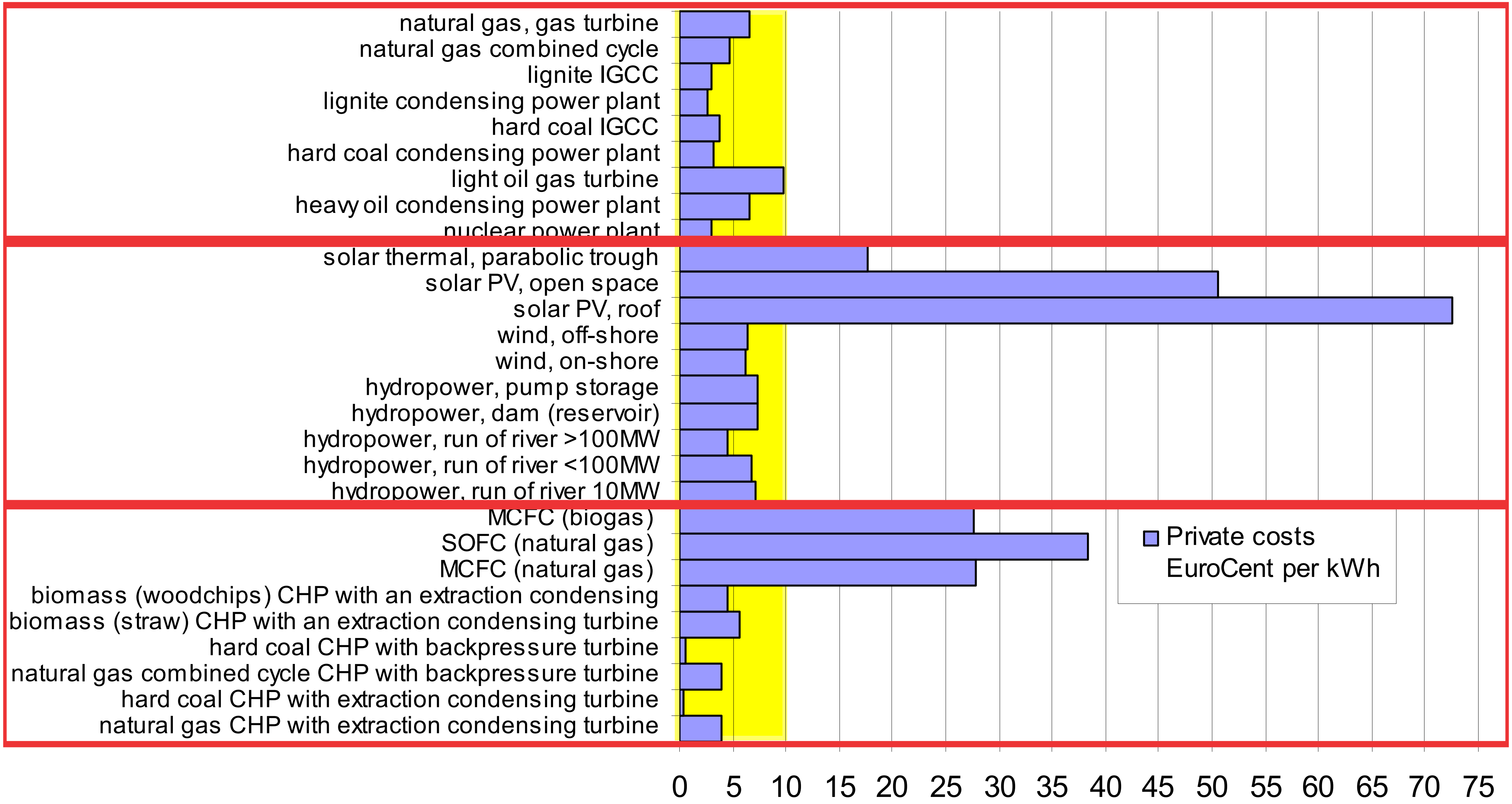
Emission weighted !





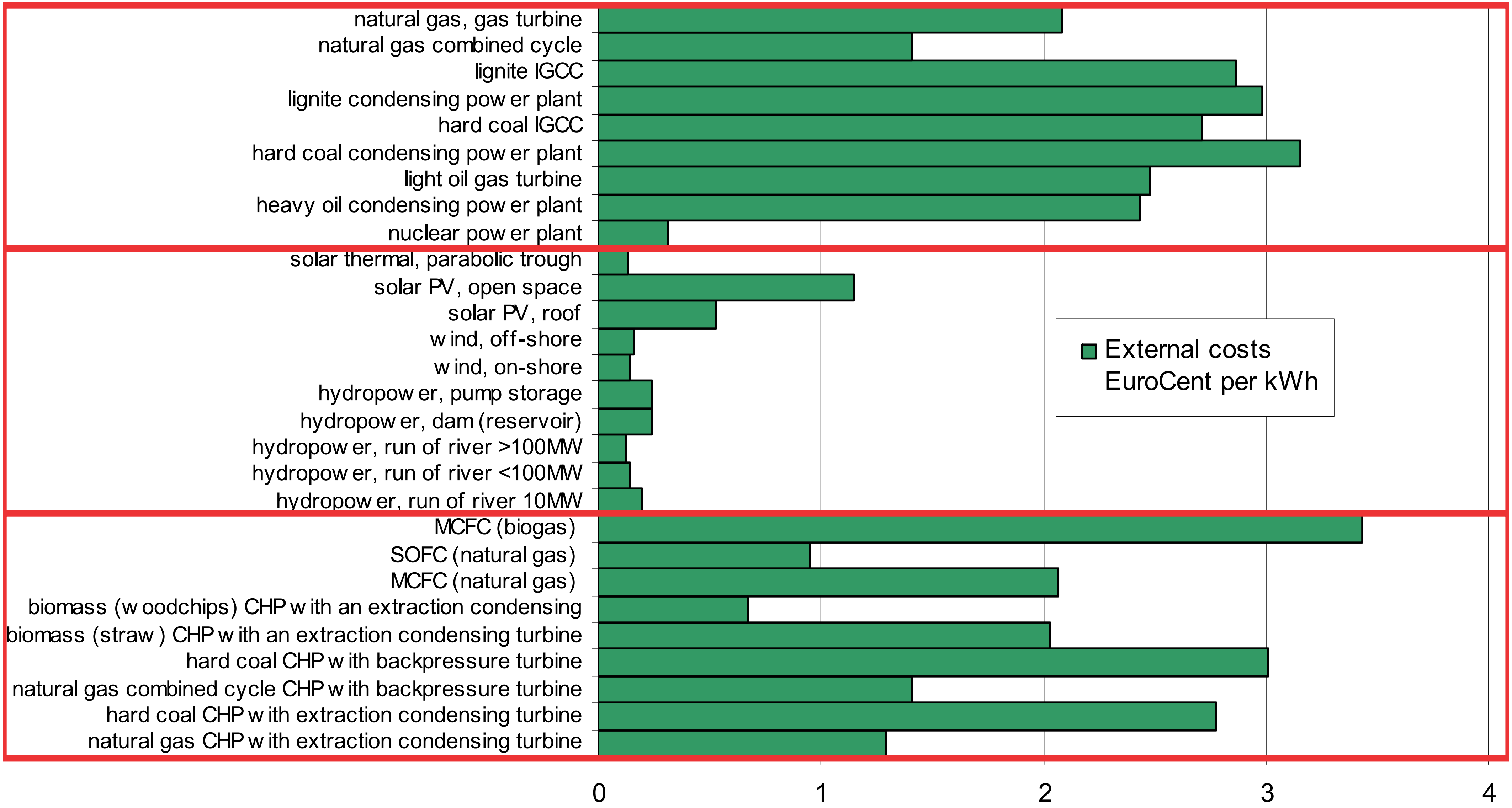
Application! Electricity Generation NEW Technologies!

Total Private Costs [Euro-Cent per kWh_{el}] (CHP by „Exergy“& solar PV EU_mid)

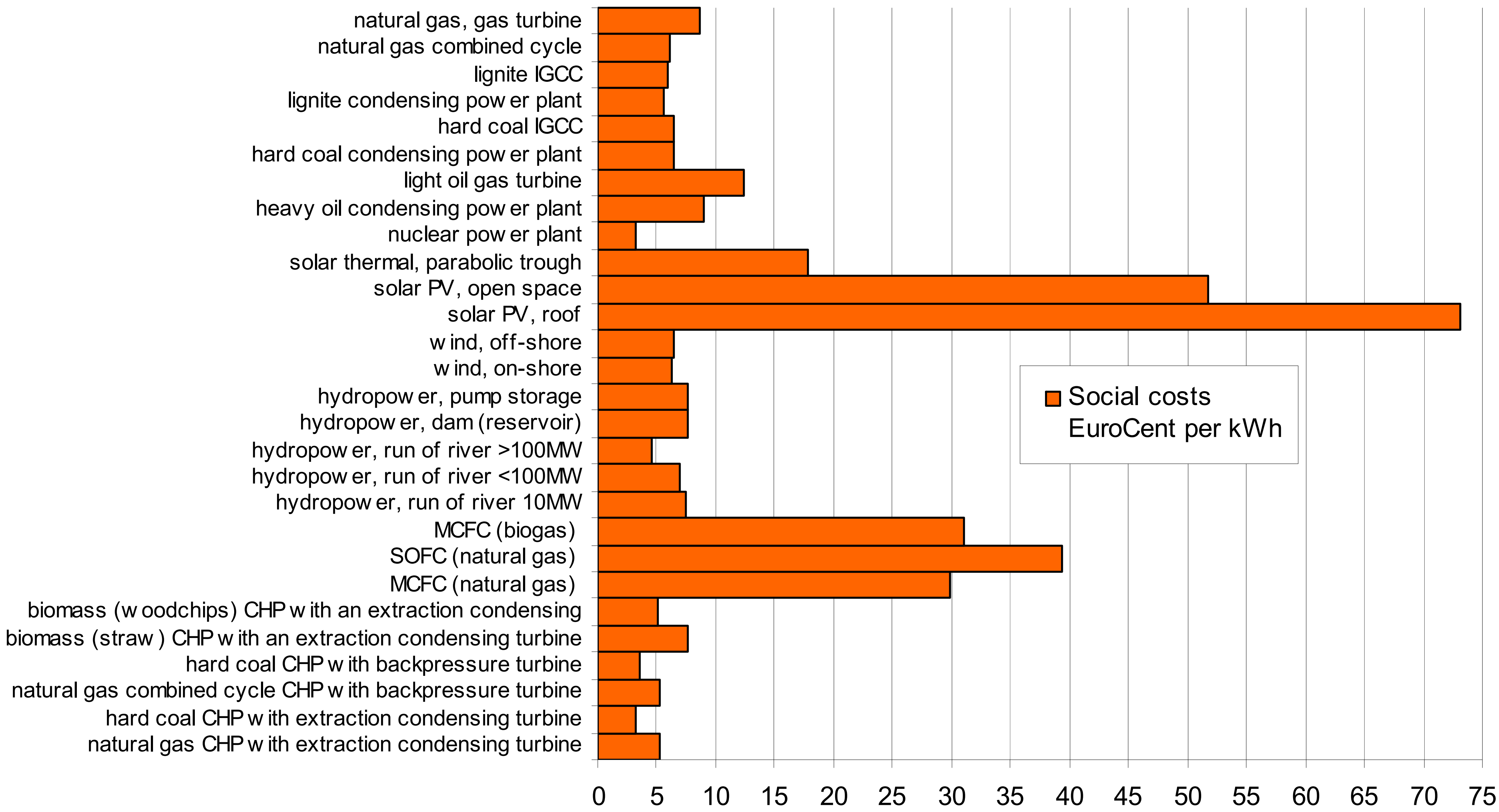


Total External Costs [Euro-Cent per kWh_{el}] at present

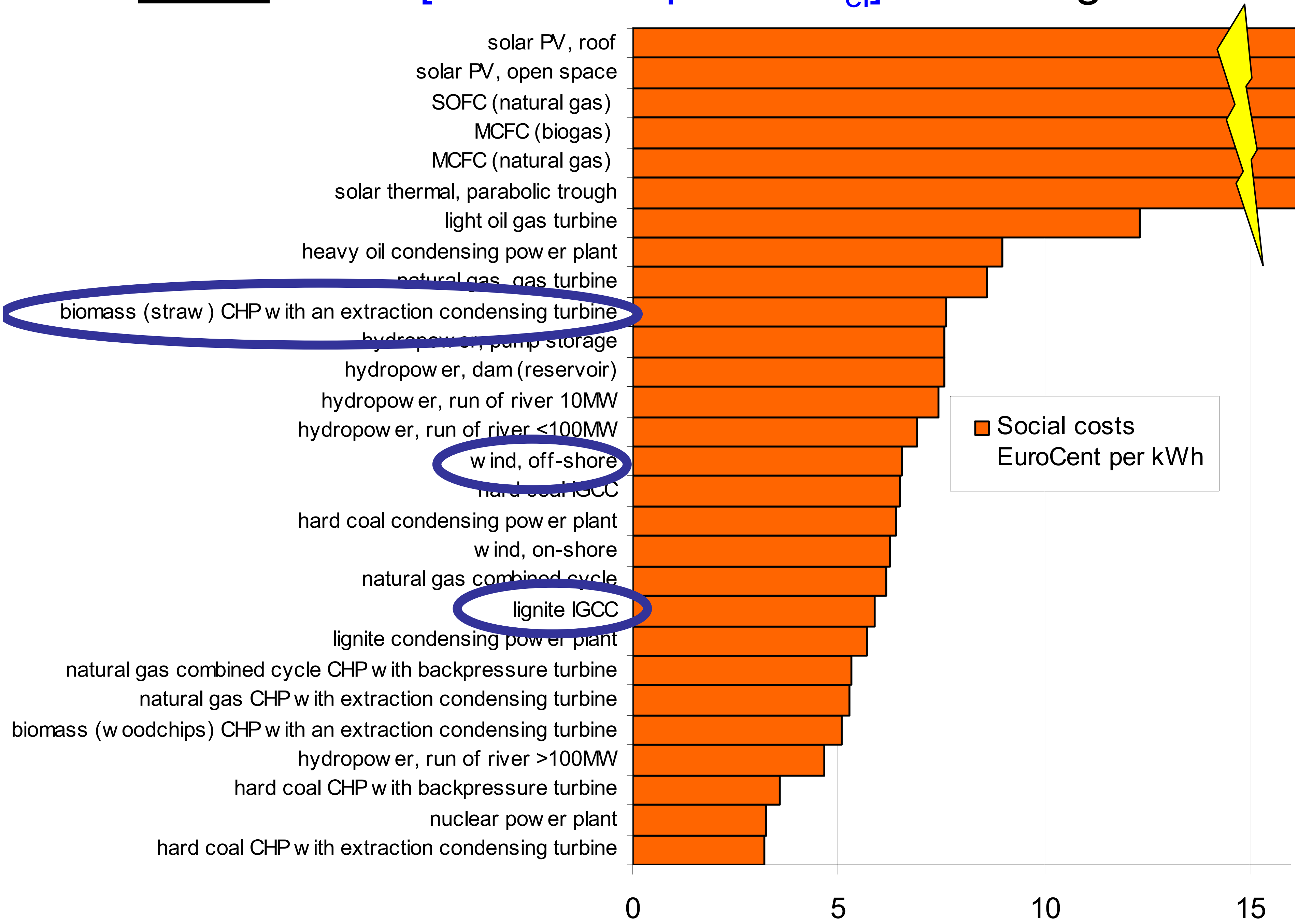
With GHG = 19 Euro per tonne $CO_{2equiv.}$



Total Social Costs [Euro-Cent per kWh_{el}]



Total Social Costs [Euro-Cent per kWh$_{el}$] - Ranking



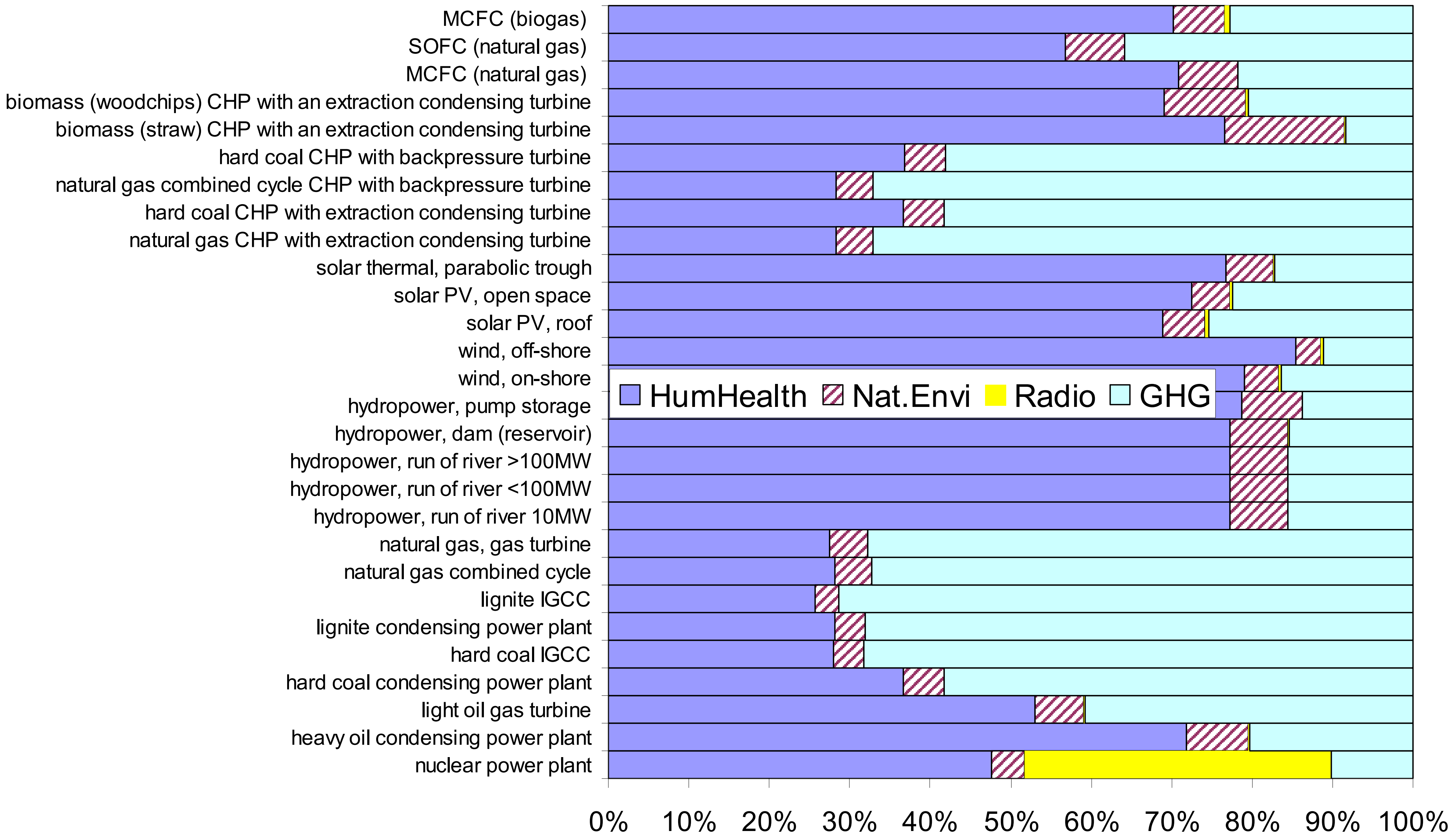
Summary

- ✓ IPA is necessary to estimate actual impacts of emissions because they can be very site specific
- ✓ Generalised generic values are often necessary for implementation
- ✓ Total social costs and not only environmental performance nor only private costs have to be taken into account
- ✓ Most important substance are covered.

More information

ExternE:	http://www.ExternE.info
EcoSenseWeb:	http://EcoSenseWeb.ier.uni-stuttgart.de
NEEDS project:	http://www.needs-project.org
CASES project:	http://www.feem-project.net/cases
email:	Philipp.Preiss@ier.uni-stuttgart.de

Shares of Different Impact Categories



Aggregated results [Euro per tonne emission] per country→ example NO_x or NH_3

Emission weighted !