

# The Impact Pathway Approach: - From Pressures to Costs with EcoSenseWeb

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# Presentation Outline

- Aims and principles of Impact Pathway Approach (IPA)
- Important pollutants considered
- Example for impact assessment – “from emission to external costs”
- 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) caused by 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)*

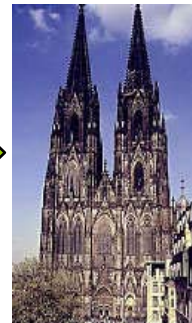
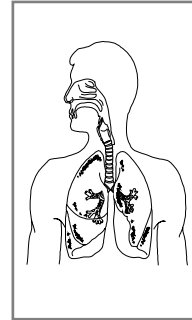
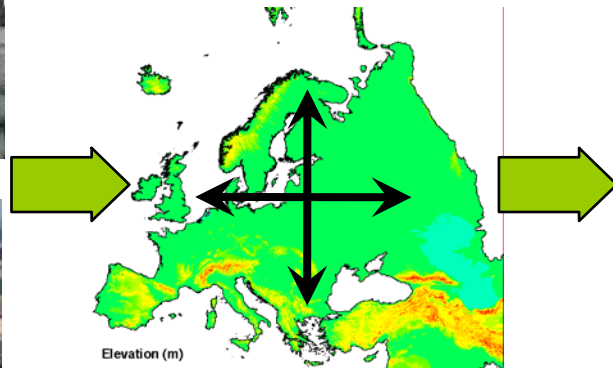
# Impact Pathway Approach (IPA) – first part

## Damage

### Emission



### Transport and Chemical Transformation



**From dust, SO<sub>2</sub>, NH<sub>3</sub>, NO<sub>x</sub> & NMVOC emission to air  
via dispersion and chemical transformation  
to concentration and deposition of:**

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Fine primary particles with diameter below 2.5 µm (PPM2.5)

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Coarse primary particles with diameter between 2.5 and 10 µm (PPMco)

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Secondary Inorganic Aerosols (SIA) - ammonium nitrate and sulphate particles

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Dry and wet deposition of oxidized and reduced nitrogen

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Dry and wet deposition of sulphur

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Ozone (SOMO35: sum over means of 35 ppb)

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Further substances also included:  
**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 Years of Life Lost  
$$= 6.5 \cdot 10^{-5} \cdot \Delta \text{conc. PPM2.5} \cdot \text{Population}$$

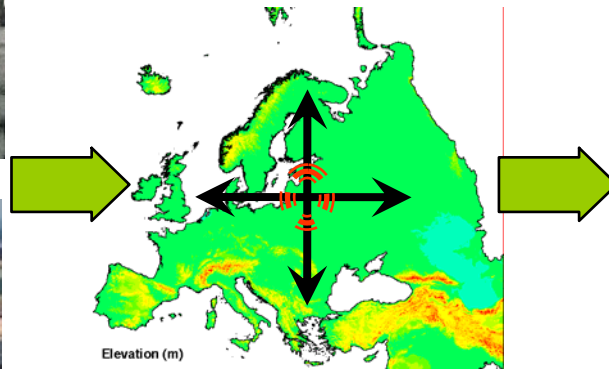
Number of **Years of Life Lost [YOLL]** due to 1 tonne of fine dust PPM2.5 emitted at a location in Europe leads to a range of ca. 0.01 to up to 15 life years lost.

# Impact Pathway Approach → Weighting and Aggregation

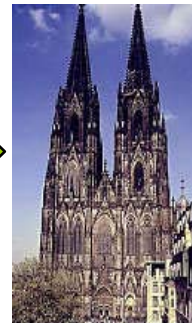
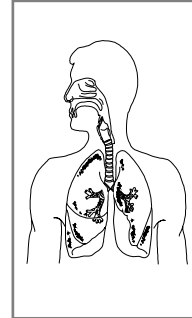
## Emission



## Transport and Chemical Transformation



## Damage



## 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 :**

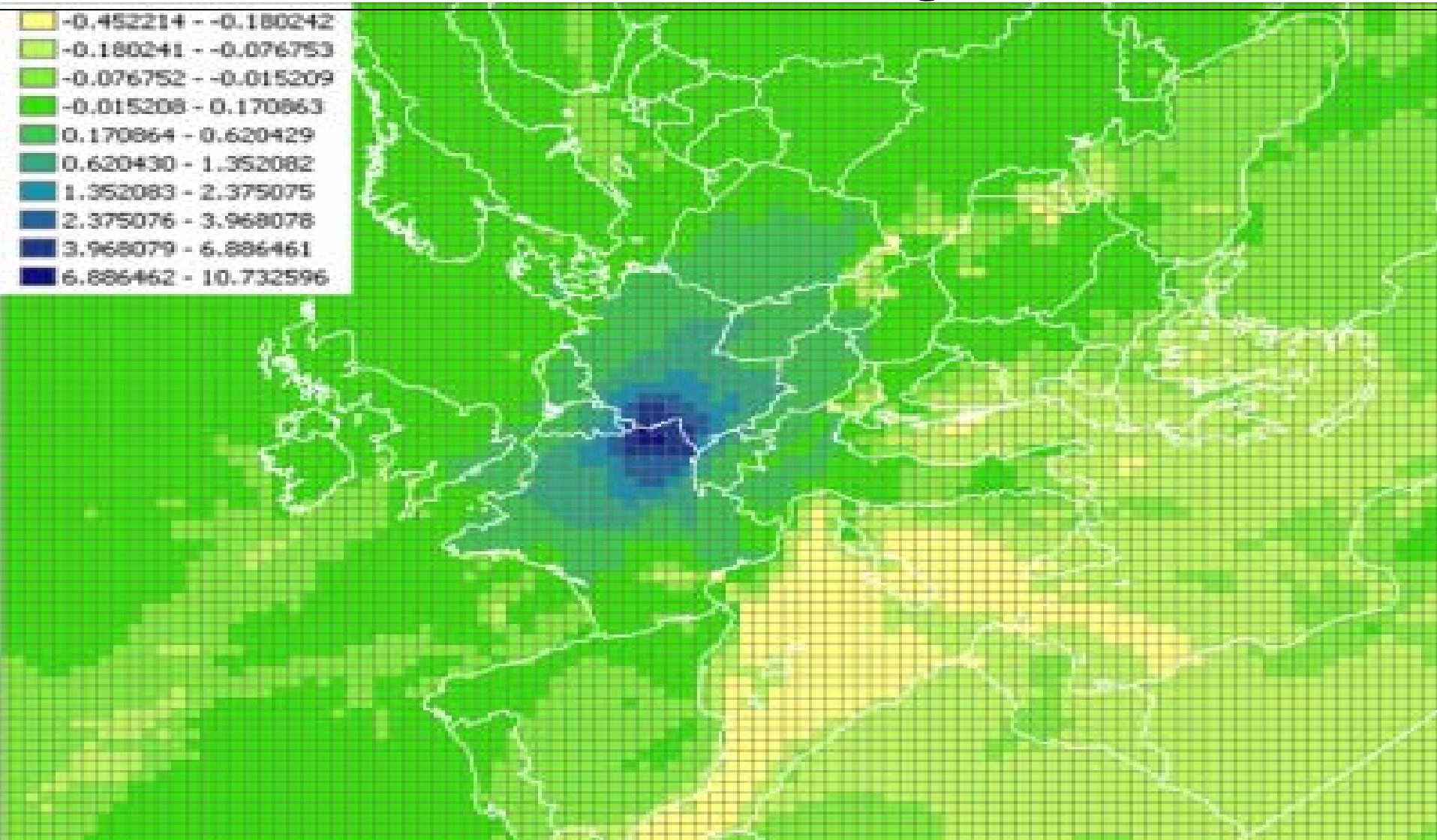
**0.5 YOLL per tonne PPM2.5 \* 40,000 Euro per YOLL**

**= 20,000 Euro per tonne PPM2.5**

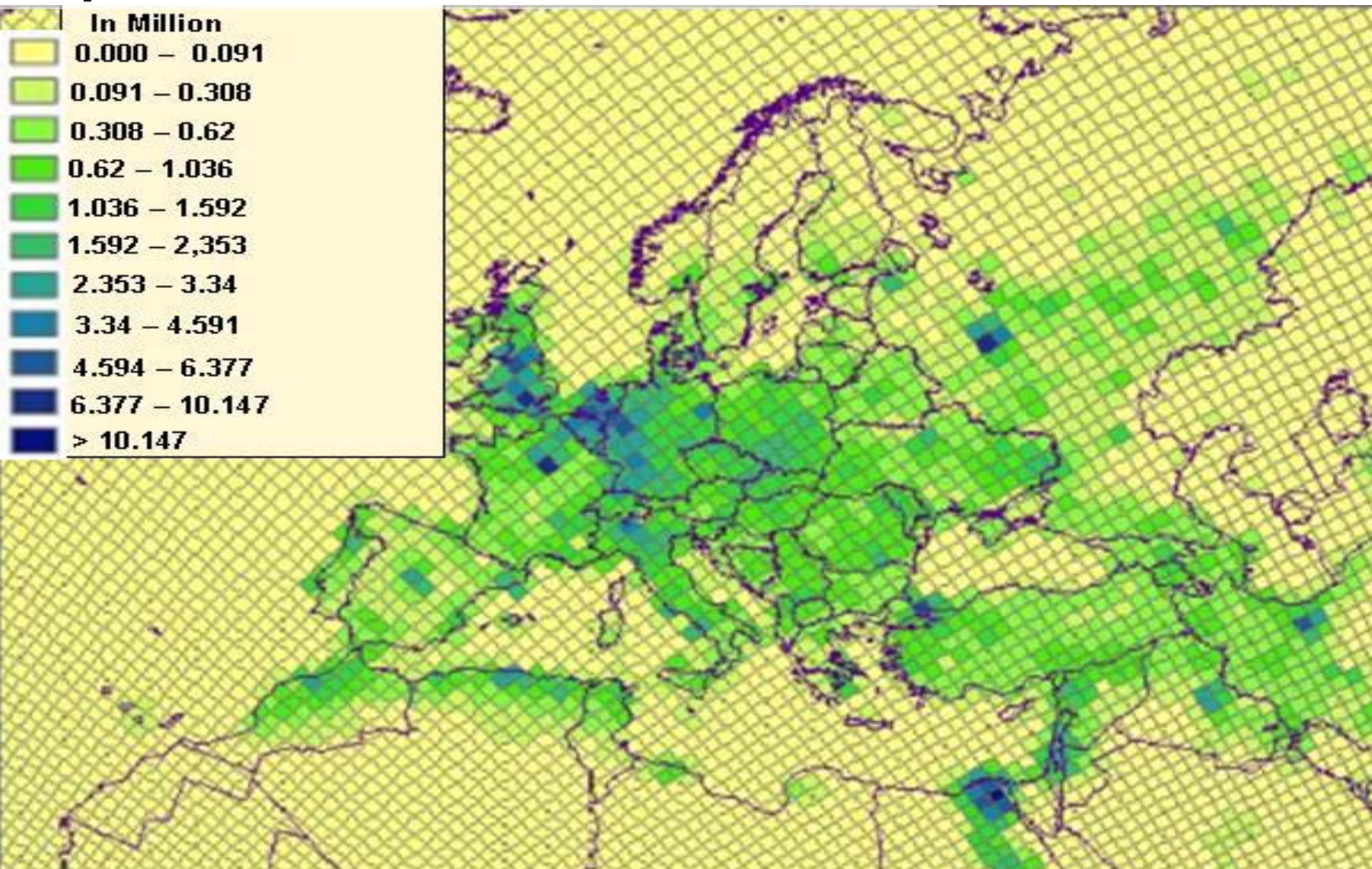
Primary particles:

delta emission → delta concentration =  
independent of background emissions

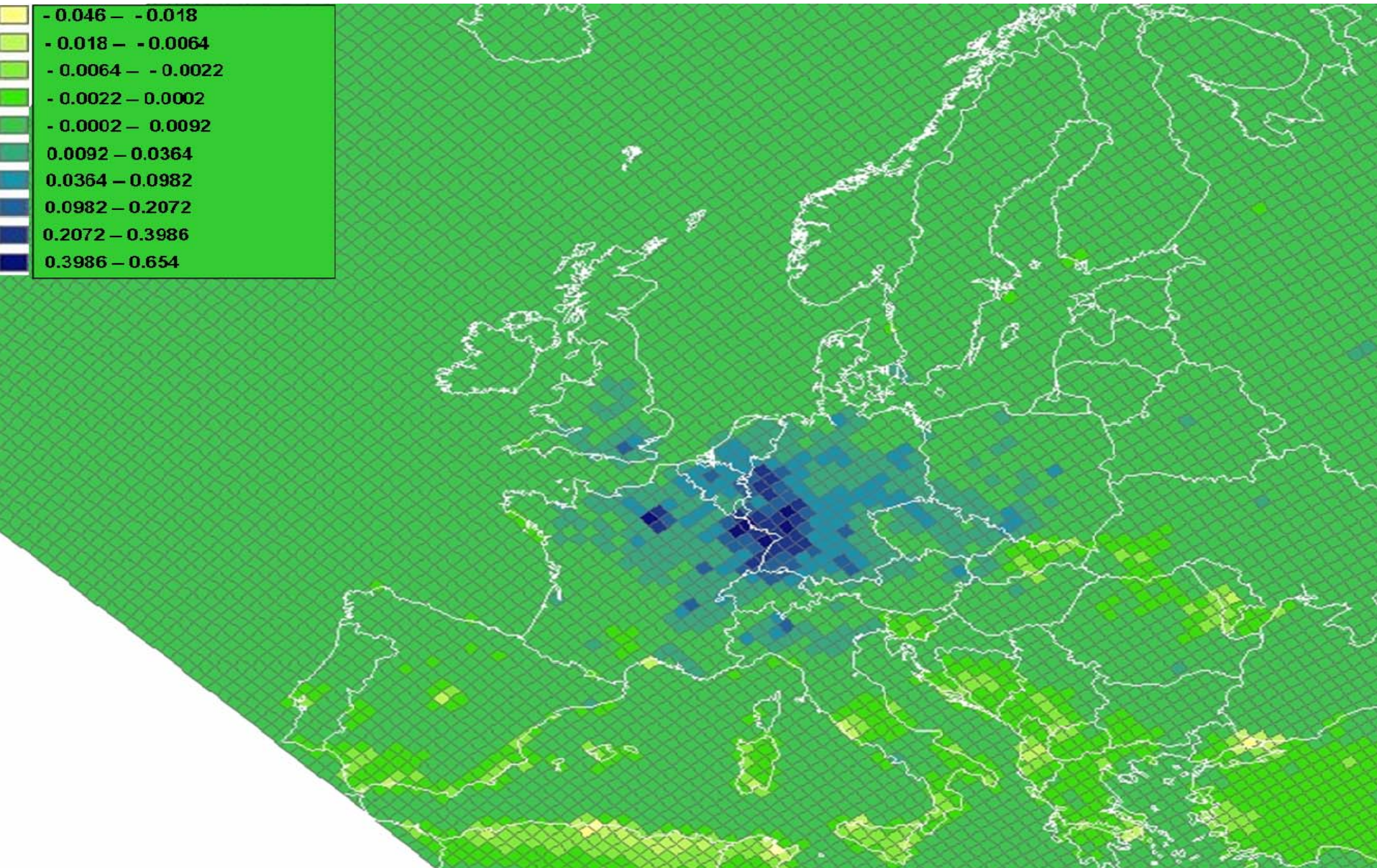
# Concentration change of ozone [ $\mu\text{g}/\text{m}^3$ ] due to emission of NO<sub>x</sub> near Luxembourg



# Population Distribution

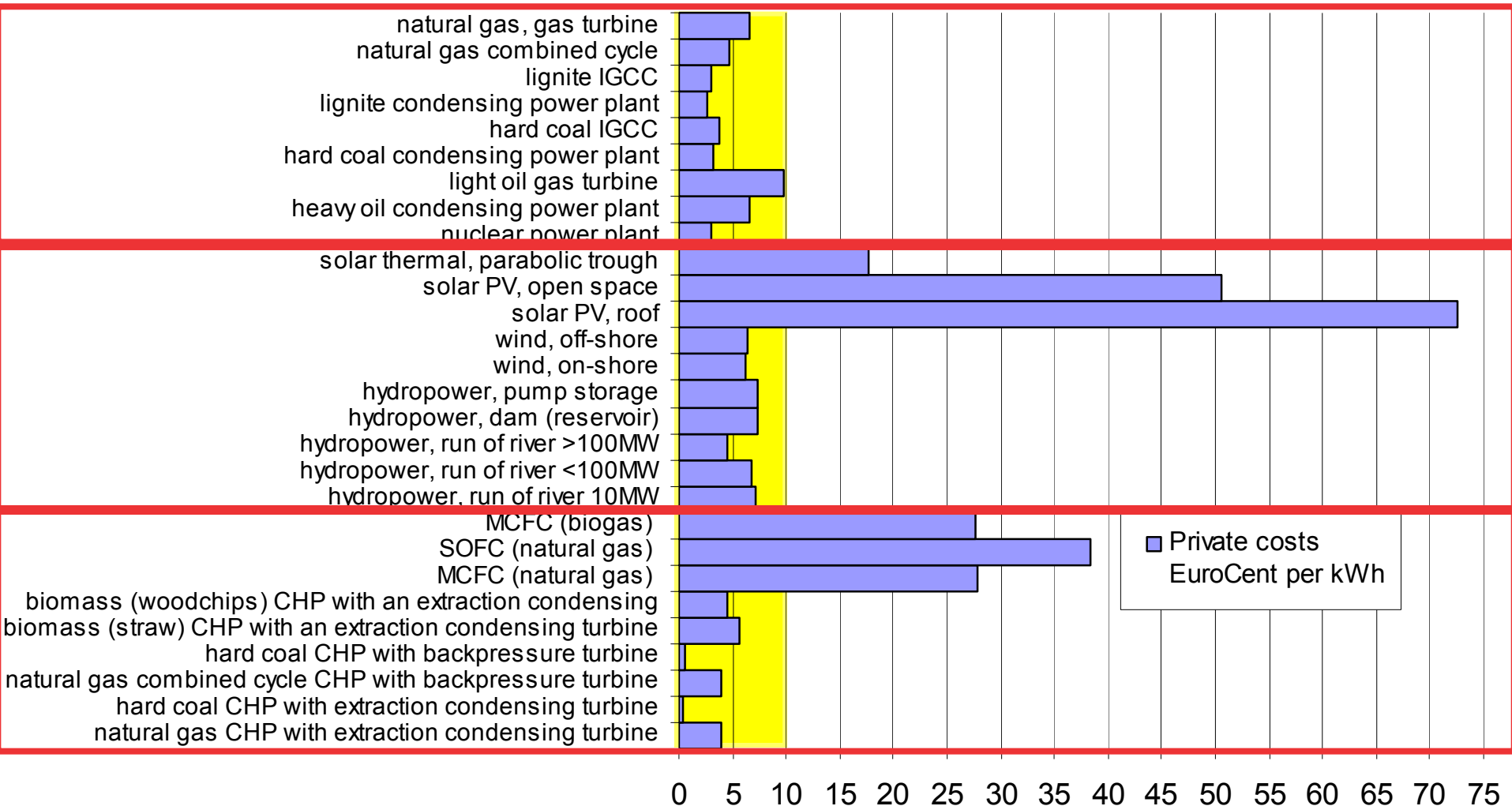


# Population \* Delta Conc.\* CRF → Life years lost



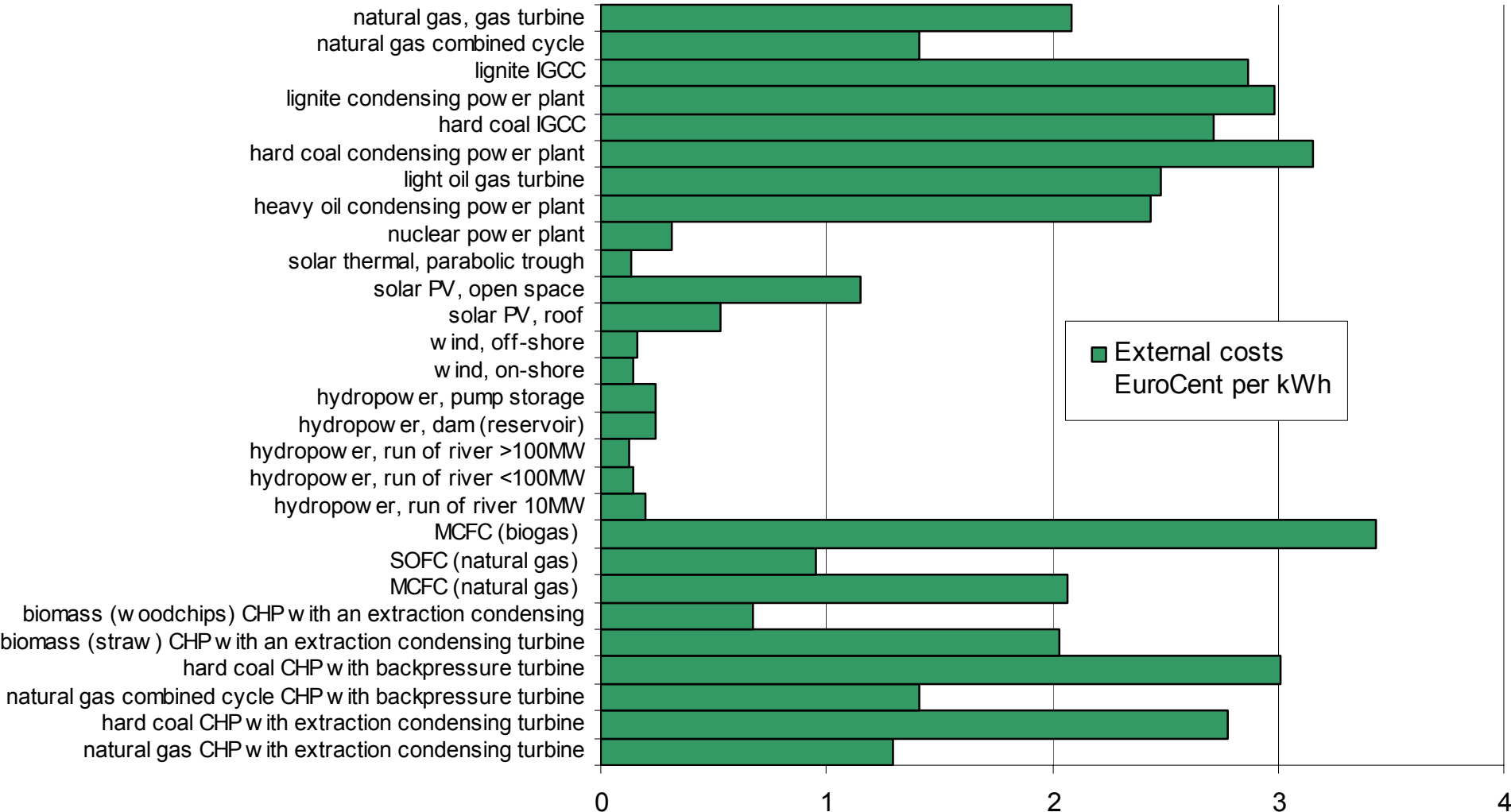
# Application! Electricity Generation NEW Technologies!

Total Private Costs [Euro-Cent per kWh<sub>el</sub>] (CHP by „Exergy“ & solar PV EU\_mid)



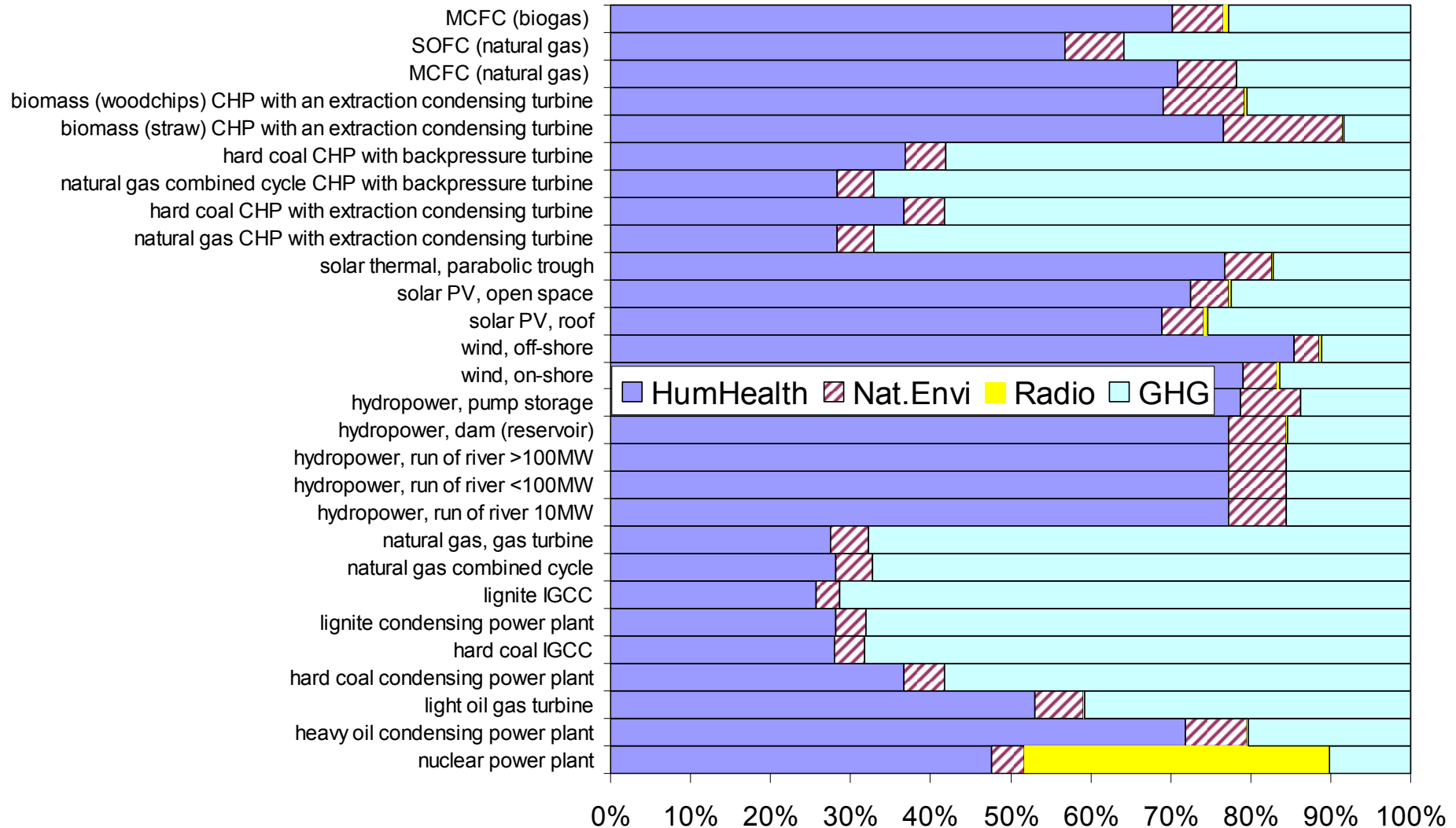
# Total External Costs [Euro-Cent<sub>2005</sub> per kWh<sub>el</sub>] at present

With GHG = 19 Euro per tonne CO<sub>2equiv.</sub>

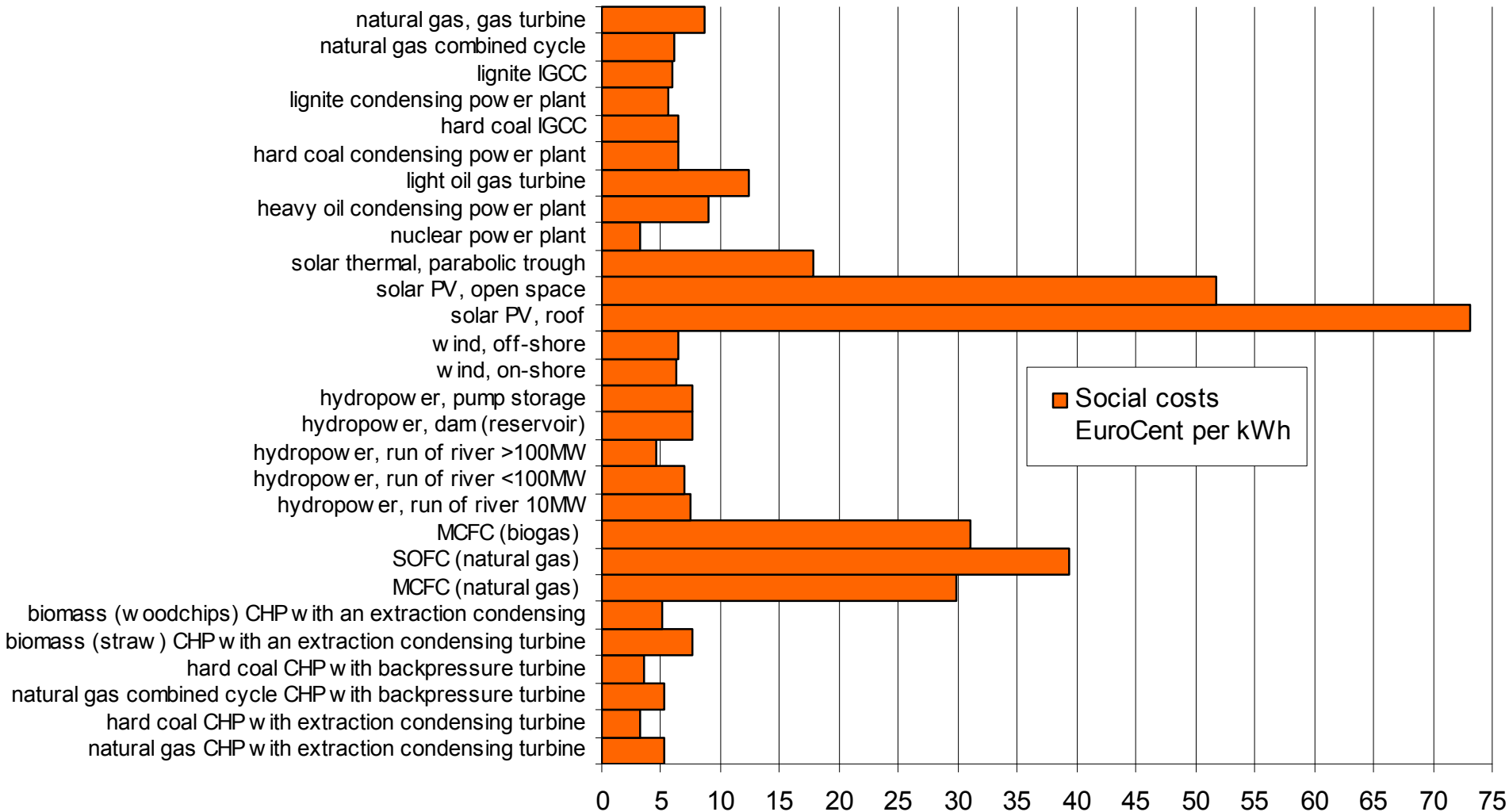




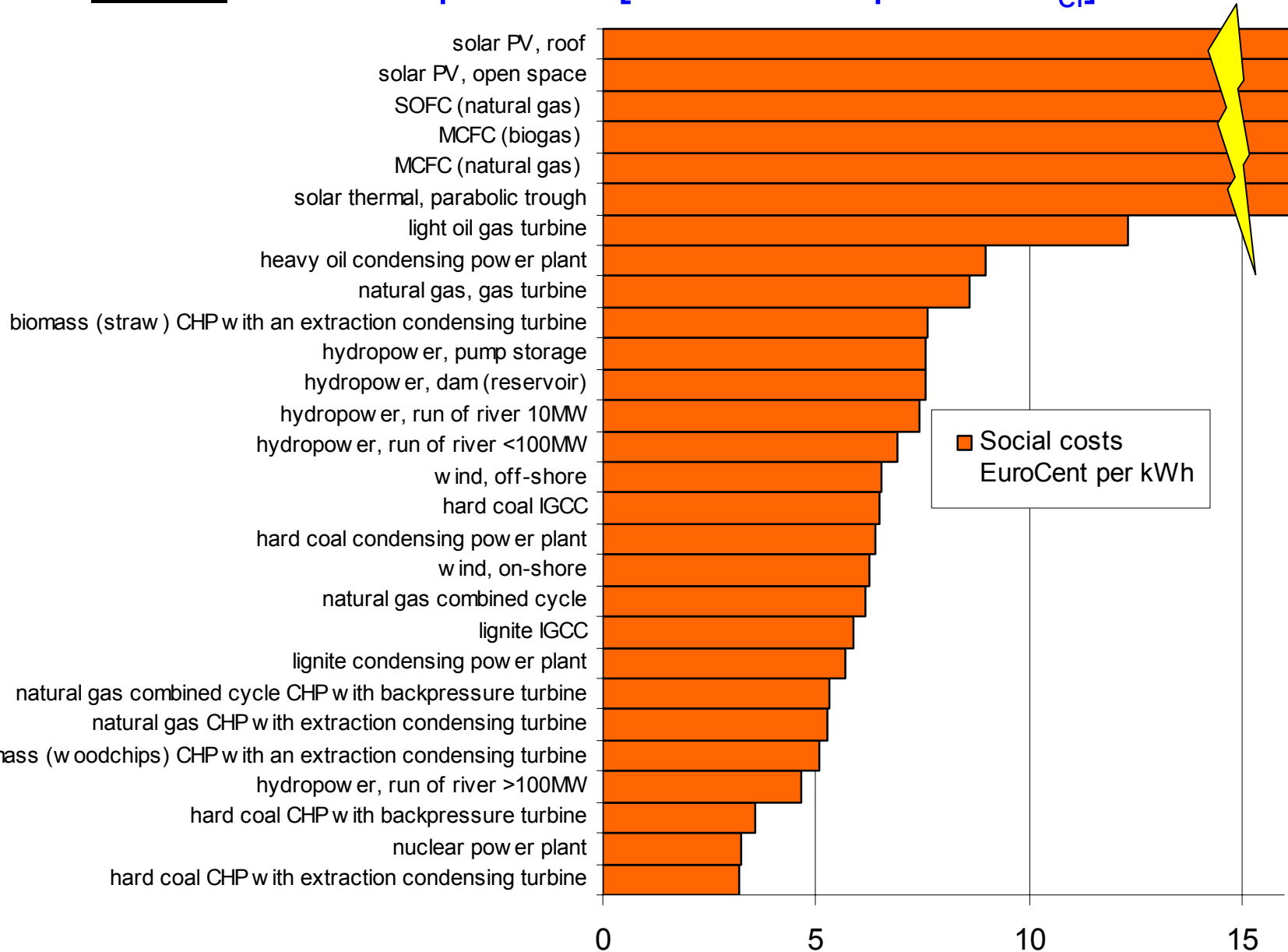
# Shares of Different Impact Categories



# Total Social Costs [Euro-Cent per kWh<sub>el</sub>]



# Total Social Costs at present [Euro-Cent per kWh<sub>el</sub>] – Ranking



# Summary

- ✓ IPA is necessary to estimate actual impacts of emissions because they can be very site specific
- ✓ Total social costs and not only environmental performance nor only private costs have to be taken into account
- ✓ Most important substances are covered and impacts are weighted according to preferences of society
- ✓ ... but MCDA can further support decisions.

## More information

CASES project: <http://www.feem-project.net/cases>

ExternE: <http://www.ExternE.info>

EcoSenseWeb: <http://EcoSenseWeb.ier.uni-stuttgart.de>

NEEDS project: <http://www.needs-project.org>

# Pollutants and their Effects on Health

Primary Pollutants	Secondary Pollutants	Impacts
Particles (PM <sub>10</sub> , PM <sub>2.5</sub> , black smoke)		mortality cardio-pulmonary morbidity (cerebrovascular hospital admissions, congestive heart failure, chronic bronchitis, chronic cough in children, lower respiratory symptoms, cough in asthmatics)
SO <sub>2</sub>		mortality cardio-pulmonary morbidity (hospitalisation, consultation of doctor, asthma, sick leave, restricted activity)
SO <sub>2</sub>	Sulphates	like particles?
NO <sub>x</sub>		morbidity?
NO <sub>x</sub>	Nitrates	like particles?
NO <sub>x</sub> +VOC	Ozone	mortality morbidity (respiratory hospital admissions, restricted activity days, asthma attacks, symptom days)
CO		mortality (congestive heart failure) morbidity (cardio-vascular)
PAH diesel soot, benzene, 1,3-butadiene, dioxins		cancers
As, Cd, Cr-VI, Ni		cancers other morbidity
Hg, Pb		morbidity (neurotoxic)