

# External Costs:

## *A Tool for Internalizing Imported Pollution*

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**Damage cost of pollution = external cost**

Imported pollution can be **internalized** by **import tax = damage cost**

For the most important pollutants the **damage costs have been calculated by**

**ExternE** = “External Costs of Energy”

funded by European Commission DG Research, since 1991

>100 scientists in all countries of EU

Major publications **1995, 1998, 2000, 2004**

[www.externe.info](http://www.externe.info)

Analogous work in the USA by EPA

# Methodology

**1) To calculate damage cost per quantity of pollutant**

Site specific **impact pathway analysis**

(analysis of the chain: emission→dispersion→impact→cost)

**2) In addition, for many choices of environmental policy:**

**Analysis of process chain**

by **Life Cycle Assessment (LCA)**

*The results are needed to **compare the costs of reducing pollution with the benefits***

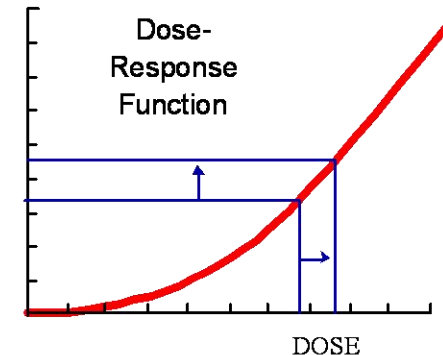
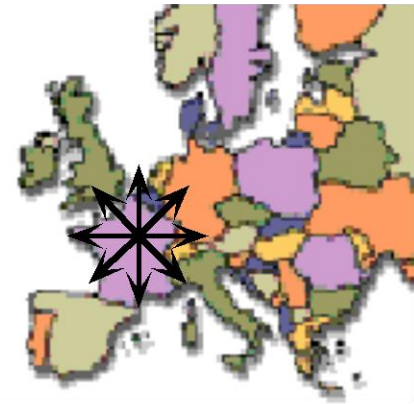
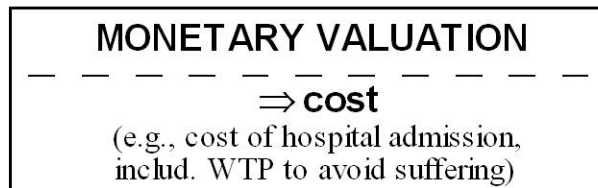
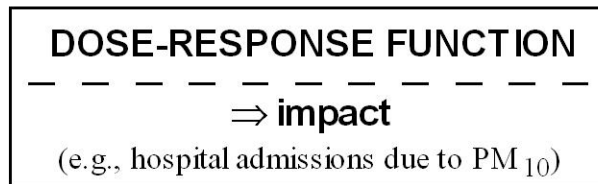
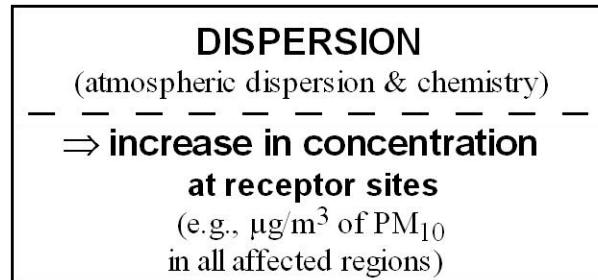
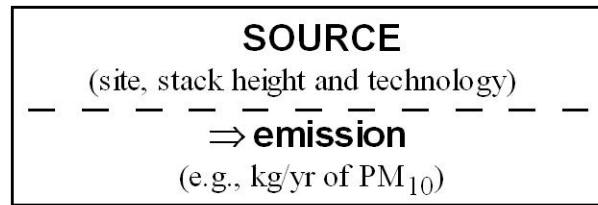
# Impact Pathway Analysis

Impacts are summed over entire region that is affected (**continent**) and all damage types that can be quantified:

- health
- loss of agricultural production
- damage to buildings and materials

**Result:**  
**€/kg of pollutant**

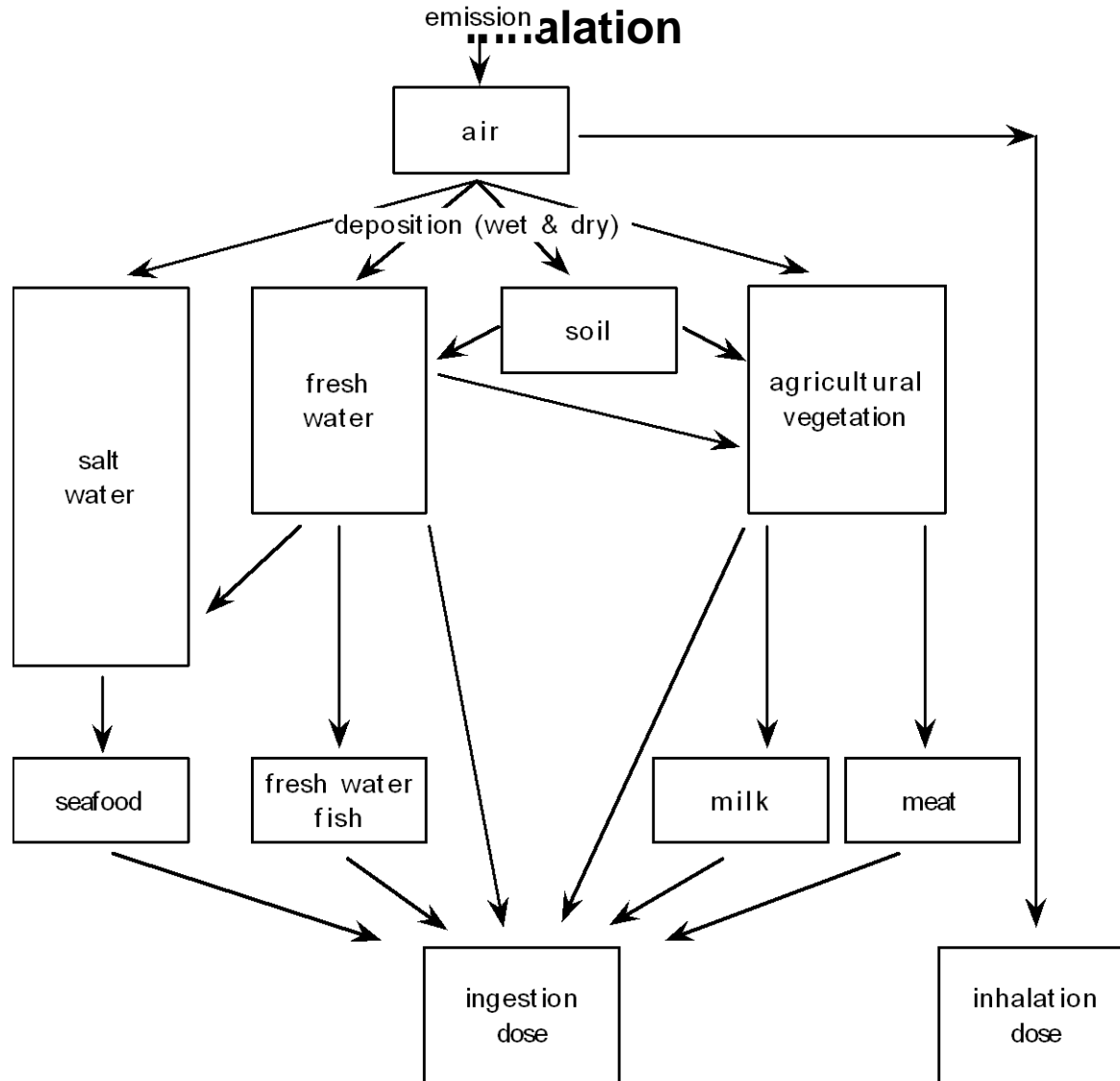
Multiply by  
kg/kWh to get  
**€/kWh**



# Pathways for ingestion

## important for Dioxins and Toxic Metals

For many persistent pollutants (dioxins, As, Cd, Cr, Hg, Ni, Pb, etc)  
**ingestion dose is about two orders of magnitude higher than**



# Relation impact pathway analysis ↔ LCA

*Example of electric power generation*

Steps of Impact Pathway Analysis →	Emission	Dispersion	Dose-response function	Monetary valuation
Stage of process chain ↓				
Fuel extraction				
Fuel transport				
Power production				
Wastes				

Goal: fill entire matrix  
(but in practice many shortcuts  
and ***conventional LCA does not calculate realistic impacts***)

# Key Assumptions

**Local + regional** dispersion models

**Linear dose-response functions for health (no threshold):**

Mostly  $PM_{2.5}$ ,  $PM_{10}$ ,  $O_3$

A few for  $SO_2$  and CO

None for  $NO_2$

Sulfates are treated like  $PM_{10}$ , Nitrates like  $0.5 \times PM_{10}$

also  $As$ ,  $Cd$ ,  $Cr$ ,  $Hg$ ,  $Ni$  and  $Pb$

**Mortality** in terms of LLE (loss of life expectancy) rather than number of deaths

**Monetary valuation** based on Willingness-to-pay (**WTP**) to avoid a loss:

**Value of a Life Year (VOLY)** due to air pollution = **50,000 €**

**Cancers 2M€/cancer**, based on  $VSL = 1 \text{ M€}$

( $VSL = \text{“Value of Statistical Life”} = \text{WTP to avoid risk of an anonymous premature death; typical values used in EU and USA } 1\text{-}5 \text{ M€}$ )

# Impacts evaluated

- 1) Global warming (CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O)  
Damage cost **20 €/t<sub>CO2</sub>**

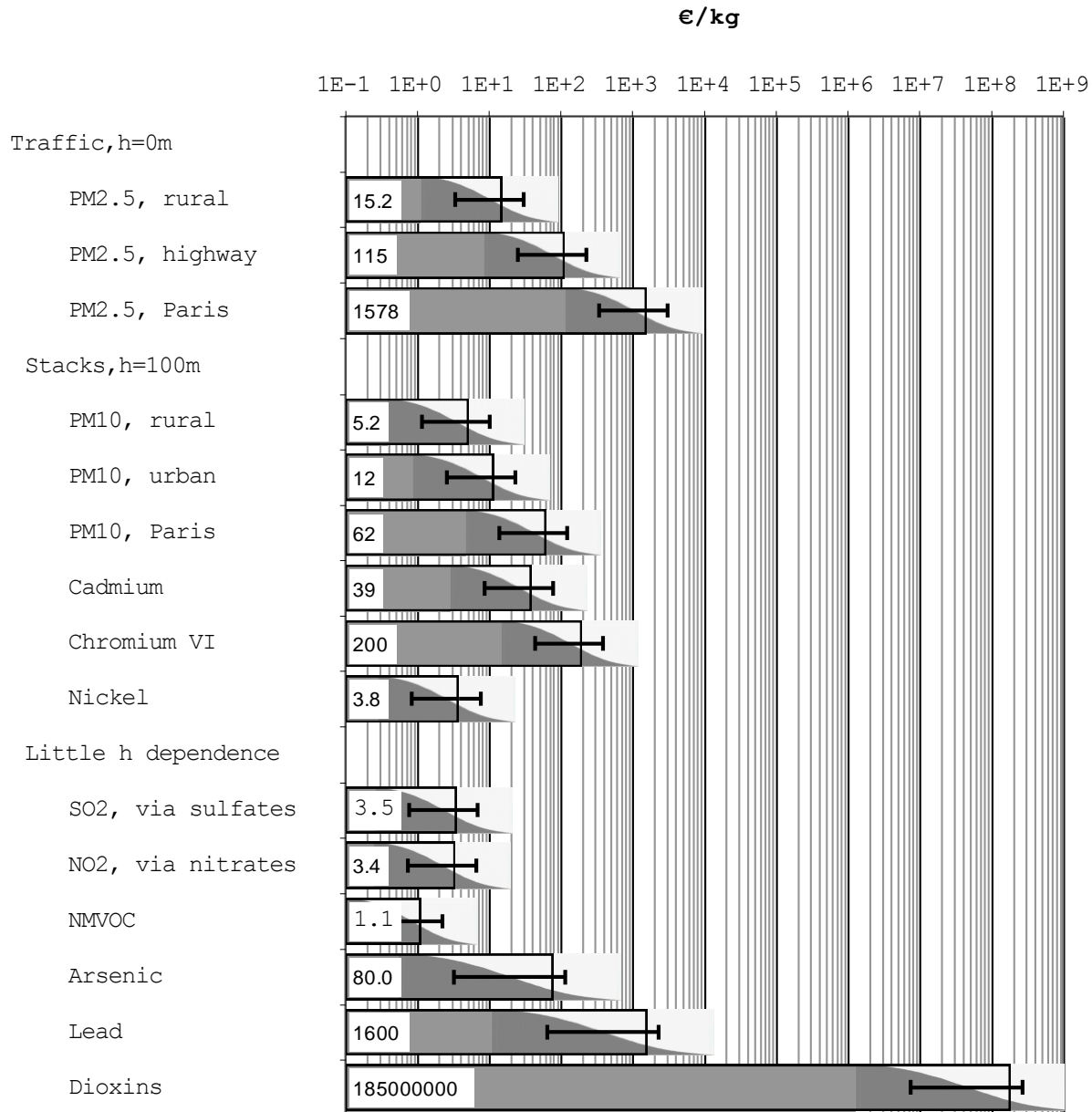
- 2) NO<sub>x</sub>, SO<sub>2</sub>, PM etc (primary & secondary pollutants)

- **Health** (morbidity: ~ 30% of total cost  
mortality: ~65% of total cost, other than global warming)
- **Buildings & materials**
- **Agricultural crops**
- **Global warming**
- Beginnings of analysis for **acidification & eutrophication**

Other burdens

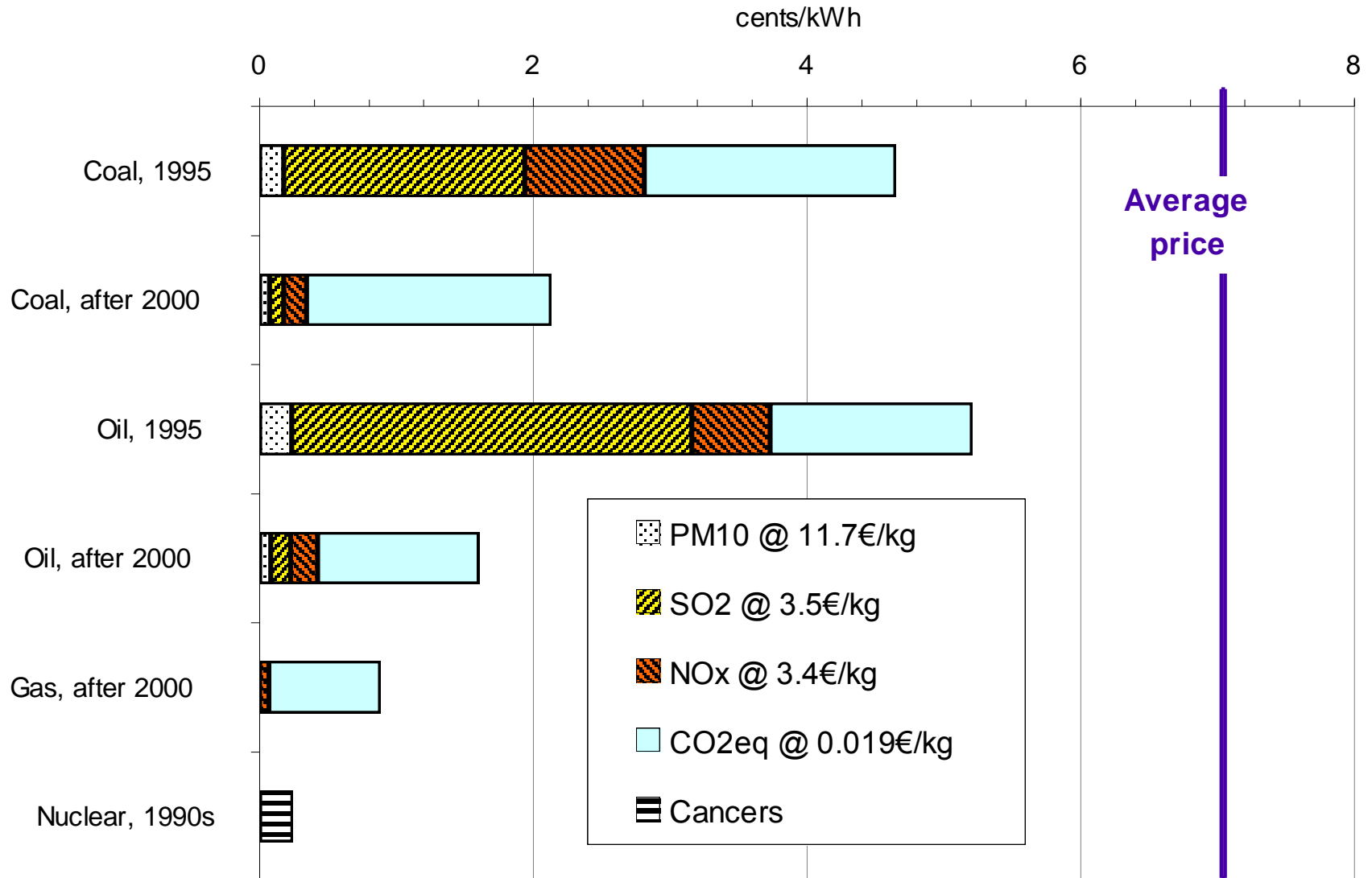
- **Amenity** (noise, visual impact, recreation)
- **supply security**

# Damage Cost per kg of Pollutant, (typical values for Central Europe) and uncertainty (error bars and probability distribution)



# Results for Power Plants

Typical numbers for Central Europe (Externe 2004). Average price France



# Conclusions

Imported pollution can be **internalized** by **import tax = external cost**

Values of external costs are available from ExternE  
(“exact” site-specific values calculated with *EcoSense* software,  
but typical regional averages can be calculated with simple  
approximation (the “Uniform World Model”, see *RiskPoll* software of  
[www.arirabl.org](http://www.arirabl.org) or [www.externe.info](http://www.externe.info))

The most important pollutants:

**CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O** (*global*);

**PM<sub>10</sub>, SO<sub>2</sub>, NO<sub>x</sub>, Volatile Org. Comp.** (*regional*)

## Questions:

- Since **impact** of regional pollutants **depends on emission site**, should cost of pollution in China be based on population density of China or of EU?
- Should **valuation** be based on WTP (*willingness-to-pay*) in China or<sup>10</sup> EU?