Center for Social and Economic Research

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WP9: Quantification of Environmental Benefits

Methodology, Inputs Needed & Output Planned

Contents

- WP Objectives and idea
- Methodology
- Applications
- Our approach in DEFINE
- What goes in and what goes out?

Objectives

- To quantify external cost of electricity generation
- To quantify external cost of electric vehicle use
- To make a soft-link between environmental impact assessment on one side, and a household-level micro-simulation model and the macro model

Our concept

- **We are NOT analysing environmental *pressures* (emission) nor *state* (concentration) but aiming at *impact* (damage/benefit)**
- **Damage is expressed in terms of external costs and thus in monetary terms**
- **Utilise a theoretically sound method, i.e. be in line with welfare economics in our quantification**
- **Direct comparison with economic costs that allows to perform more complex welfare analysis**

Methodology

- ExternE project series
  - ExternE= Externalities of Energy launched in 1991, financed by DG Research within the Joule program, then within the FPs

- Scope
  - airborne pollutants from power plants
  - development of the Impact Pathway Approach

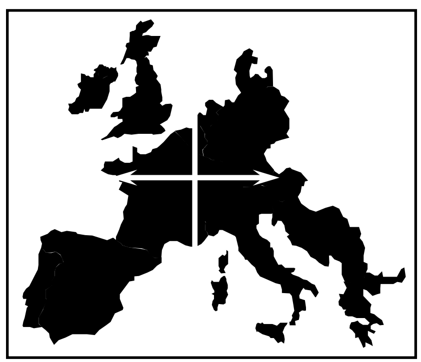
- damage associated with certain process depends on
  - ✓ technology
  - ✓ character of operation
  - ✓ site (location)
  - ✓ time
  - ✓ scope of fuel cycle

→ **bottom-up approach**
for complex pathways>
‘impact pathway approach’

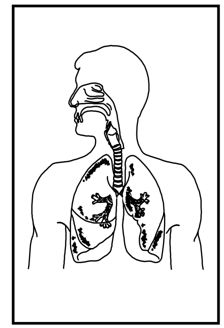
Impact pathway approach
4 Steps

EMISSIONS

DISPERSION & CHEMICAL TRANSFORMATION



PHYSICAL IMPATS



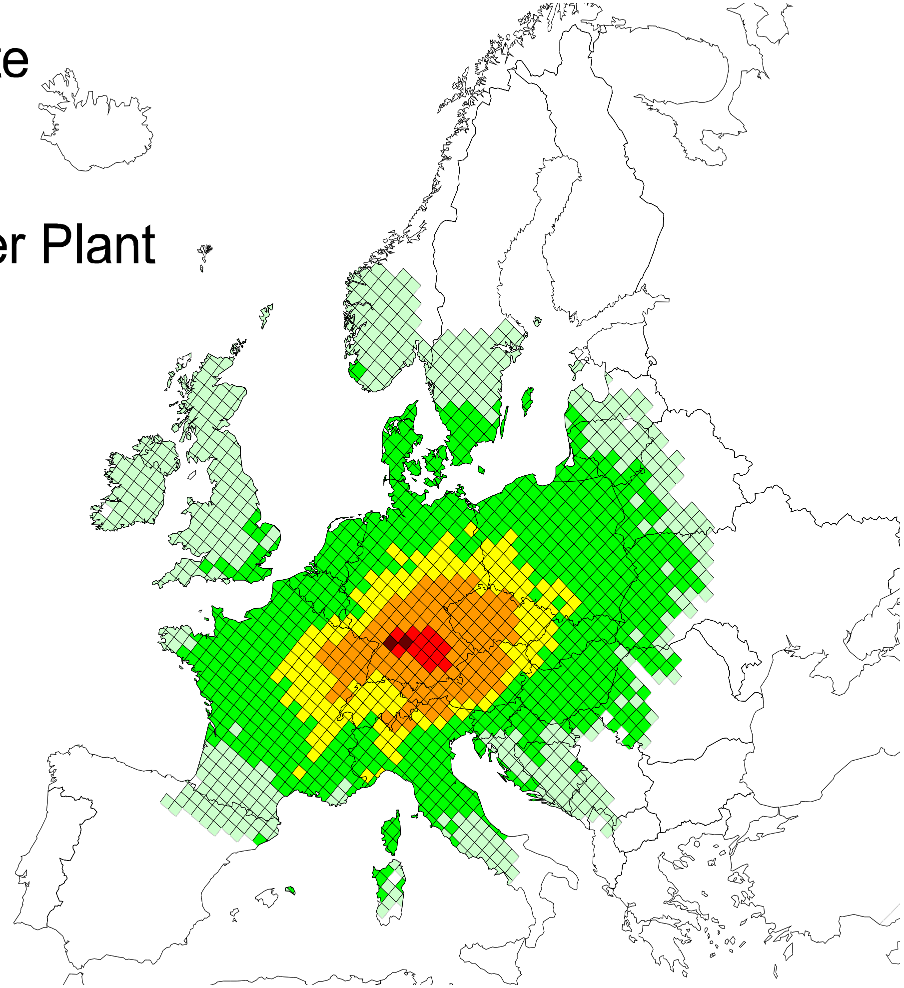
MONETARY VALUATION

Step 1: Get Data

- **Emission**
  - airborne pollutants: SO_2, NO_x, PM2.5, PM10, NH_3, NMVOC
  - GHGs
  - noise (db)
- **Technology data**
  - flue gas, fuel consumption, location
- **Output data**
  - kWh, GJ, vkm etc.

Step 2: Athmospheric dispersion
To derive marginal concentrations

Additional Sulfate Concentration caused by Coal Fired Power Plant in Lauffen



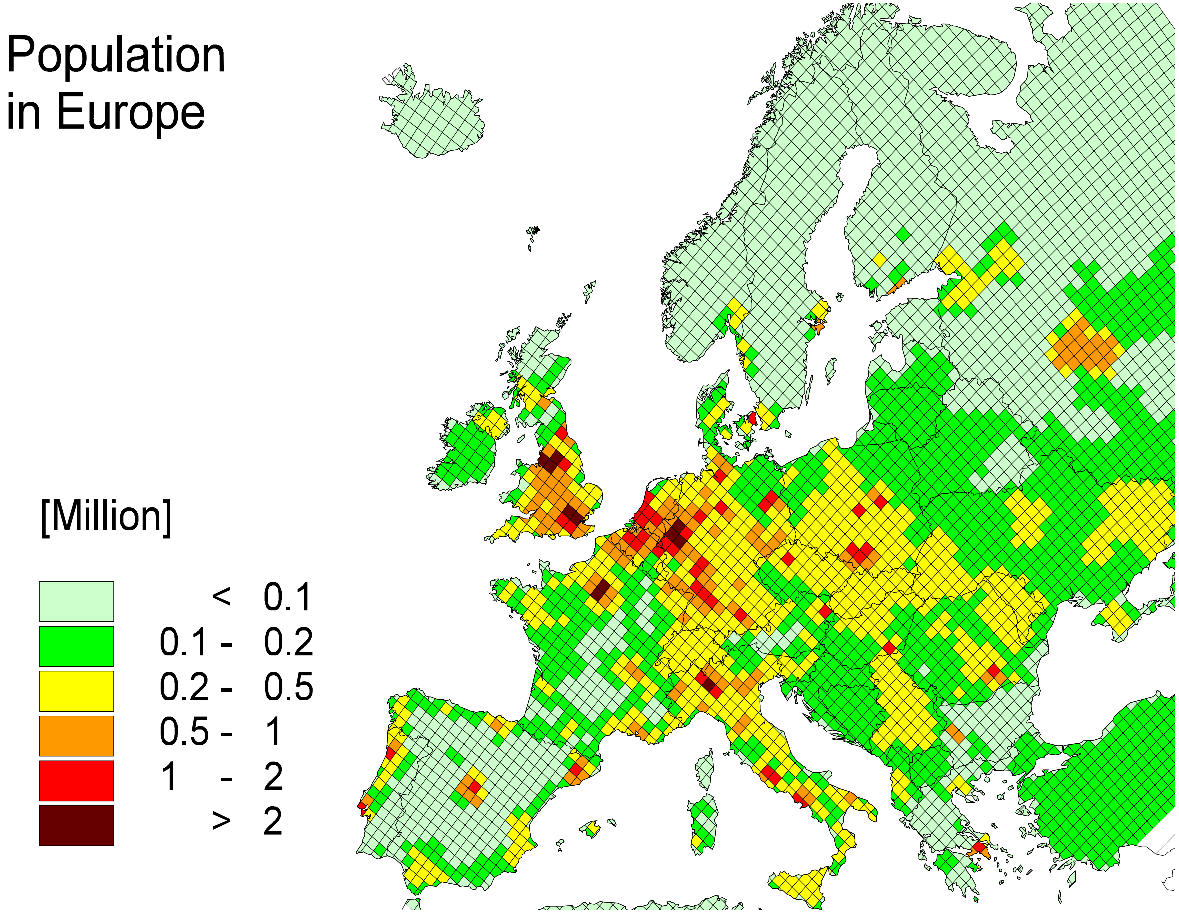
[ng/m3]

	< 0.1
	0.1 - 0.5
	0.5 - 1
	1 - 5
	5 - 10
	> 10

Step 3: From dose to response

- **Valuation is possible only if a reliable (concentration-) response function is known**
- **Review of CRF/DRF/ERF from the ExternE projects**
  - respiratory & cardiac HA, MRAD, lower respiratory symptoms, work loss days, chronic bronchitis etc. --: ozone & PM
  - premature mortality --: ozone, PM, As, Pb, Cd
  - cancers (carcinogens) --: benzene, As, Cd, Cr-IV, Ni, PCB,…
  - development toxicity (neurotoxicants), dose toxicity, sensitisation, fertility --: Pb, metyl-Hg, other REACH chemicals

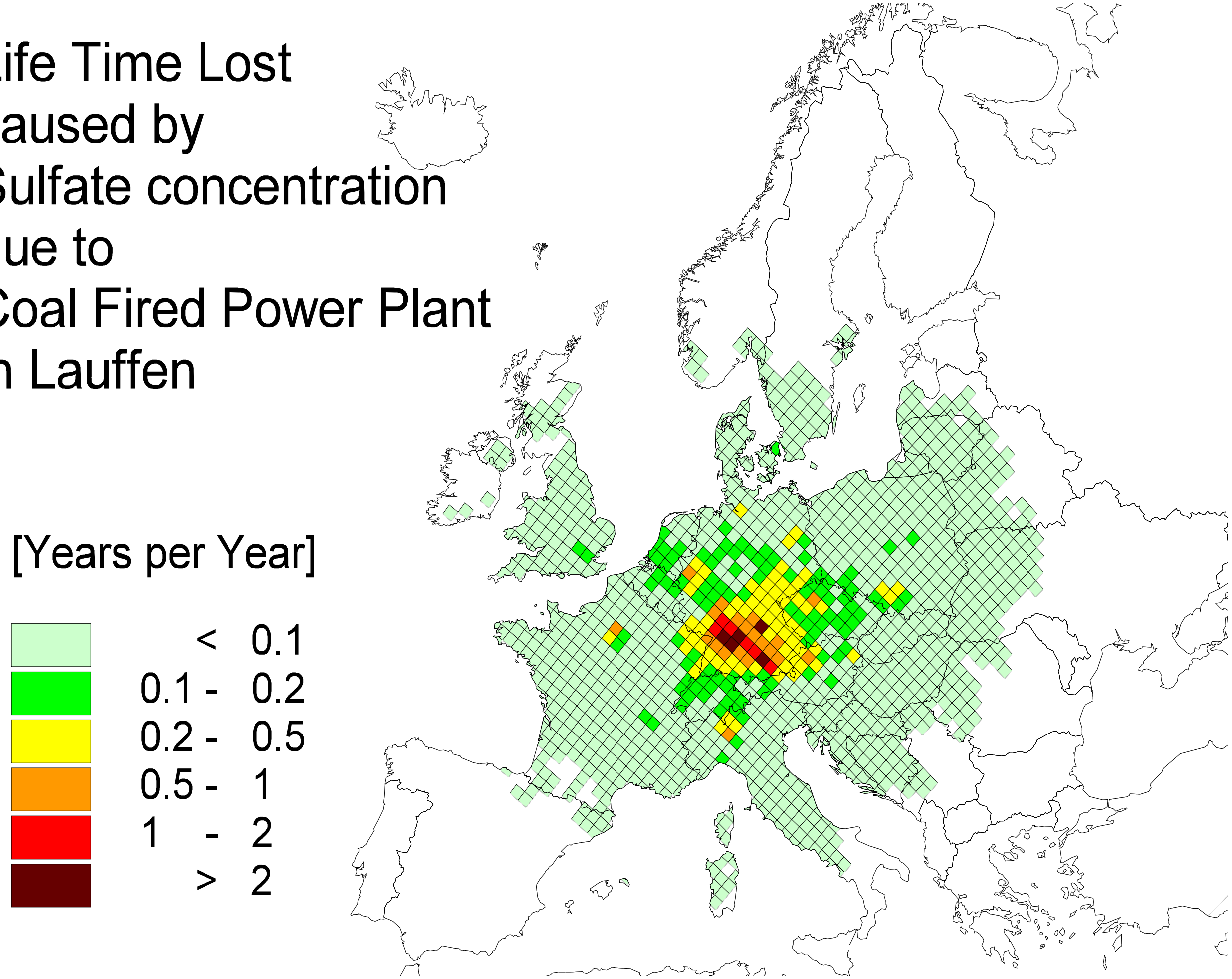
Step 3: # Receptors



Source: IER

Step 3: Cumulative response

Life Time Lost
caused by
Sulfate concentration
due to
Coal Fired Power Plant
in Lauffen



Source: IER

Last step: Attach Monetary Value on the (Physical) Impacts

elicit preference structure of the population →
How much are you willing-to-pay to avoid adverse impact (or get desired impact) ?

- **market price**
  → *building materials, crops, medical treatment costs*

- **non-market valuation**
  →*premature death, health risk, landscape amenities,….*

- ***Ex.: Health impacts valuation within the ExternE***
  - *Cost of illness (medical treatment costs) plus*
  - *Loss of productivity (due to sickness)*
  - *WTP for suffer, dis-comfort and other inconveniences*
  - *WTP for changing a risk of dying (i.e. Value of a Statistical Life)*

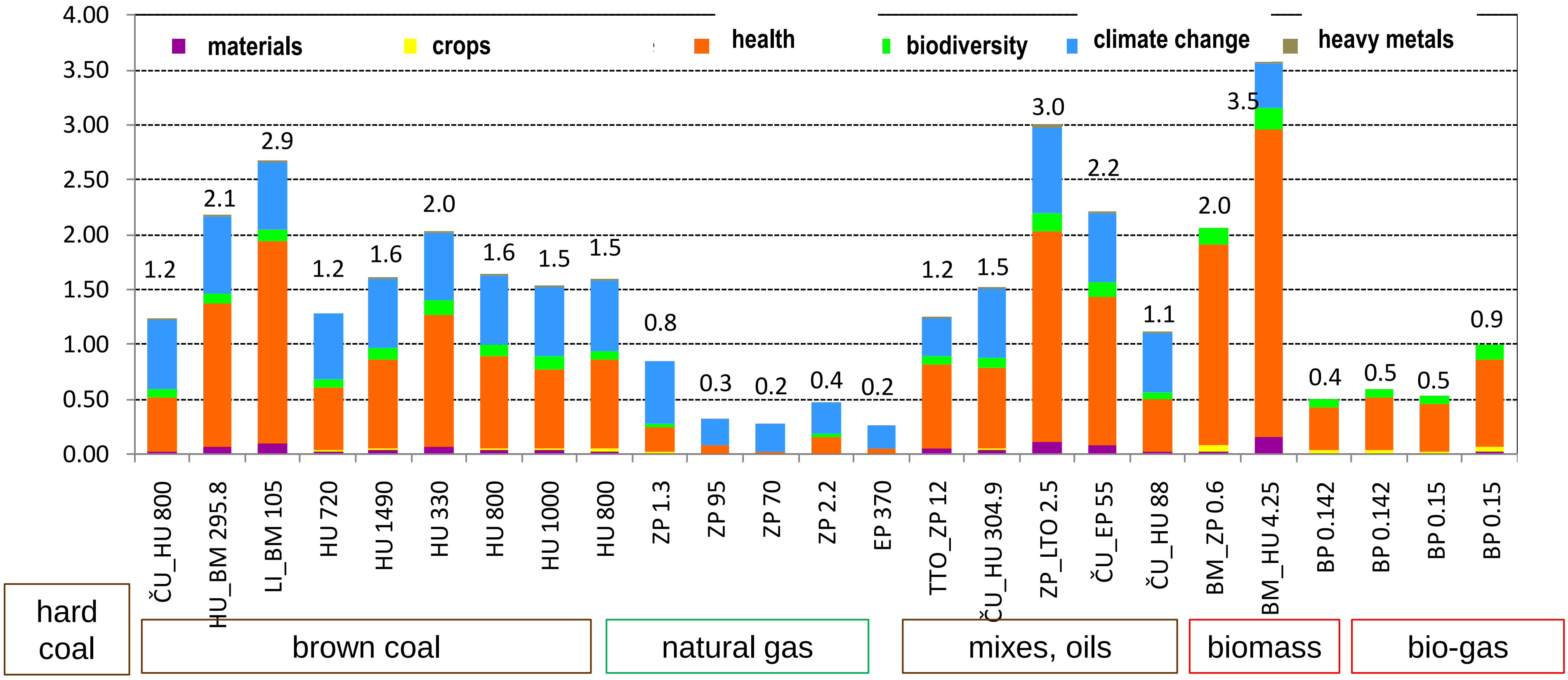
Climate Change Impacts

- **Market price**
  - EU-ETS (8-June-2012): EUA €6.65 & EUA/CER €3.39 for Dec2012
- **Marginal Abatement Costs**
  - ExternE: 19 $€_{2000}$ (MAC for Europe to reach the Kyoto Protocol for 2008-2012)
  - Meta-Analysis : 24€ (mean), 16€ (median) for 2025 by Kuik, O. (2007)
  - IAM Review: €27 (std €15) for 550ppm or €68 (std 43) for 450ppm in 2030 by ICCGOV
- **Social Costs of Climate Change**
  - marginal damage per t of C as the discounted difference in the two flows of real cost and benefits over long time period
  - based on a review of Integrated Assessment Models such as FUND, DICE, PAGE, WITCH, etc. within FPs projects (e.g., NEEDS, ADAM, ClimateCost)

Applications

External Costs of Electricity Generation

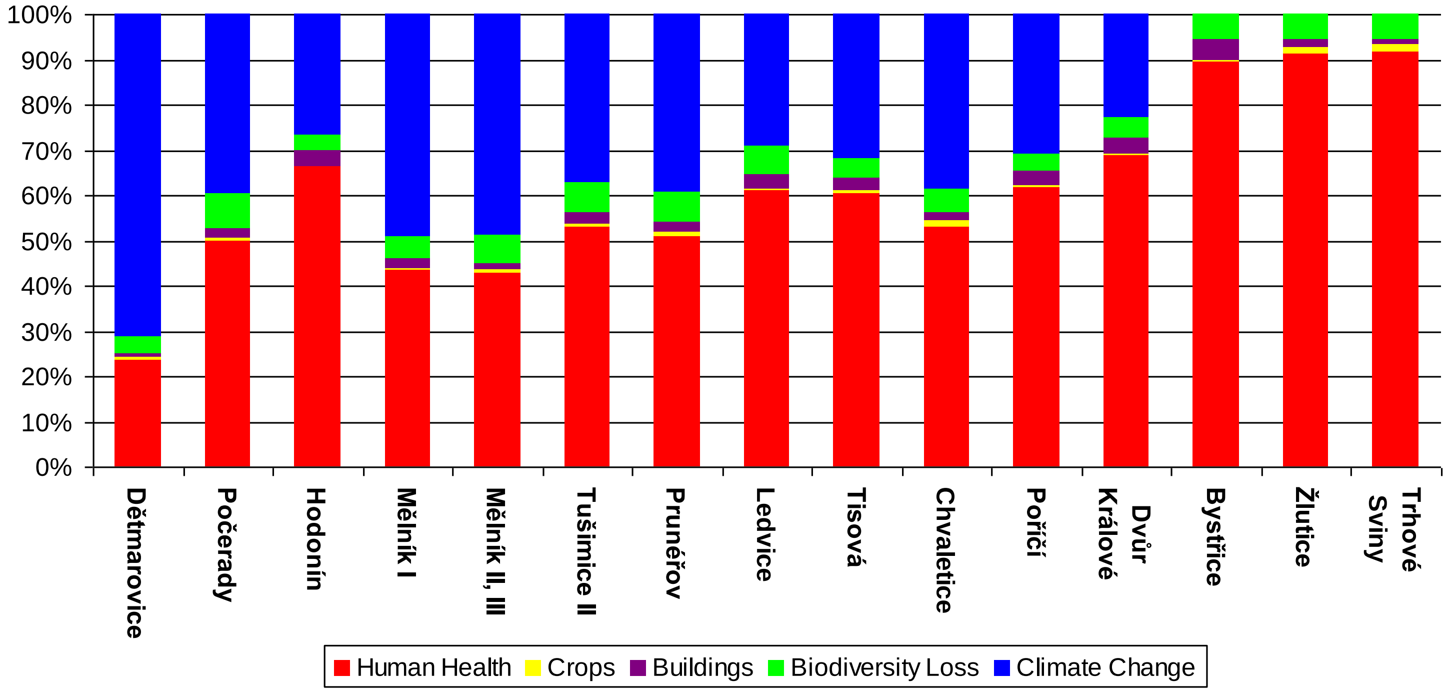
Kč per kWh (2008 prices), the Czech republic



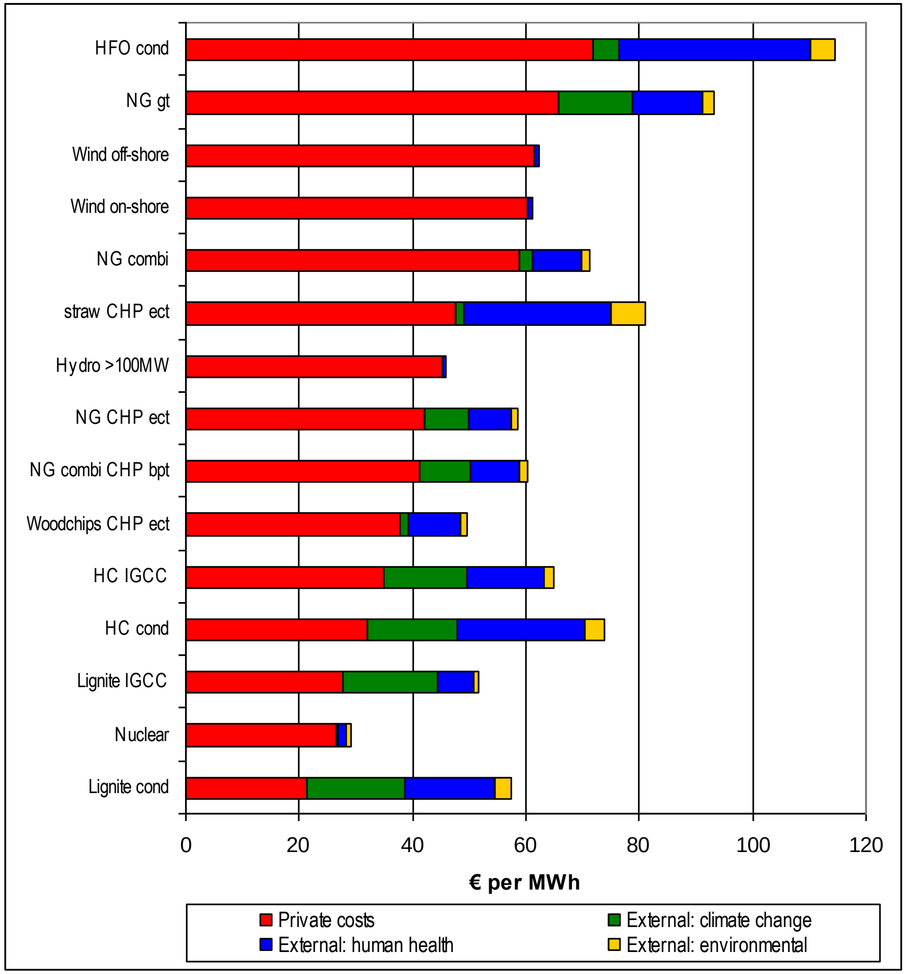
Applications

Impact categories

Energy Generation Reference Technologies, CZ



Applications
Full Cost Assessment
Energy Generation Reference Technologies

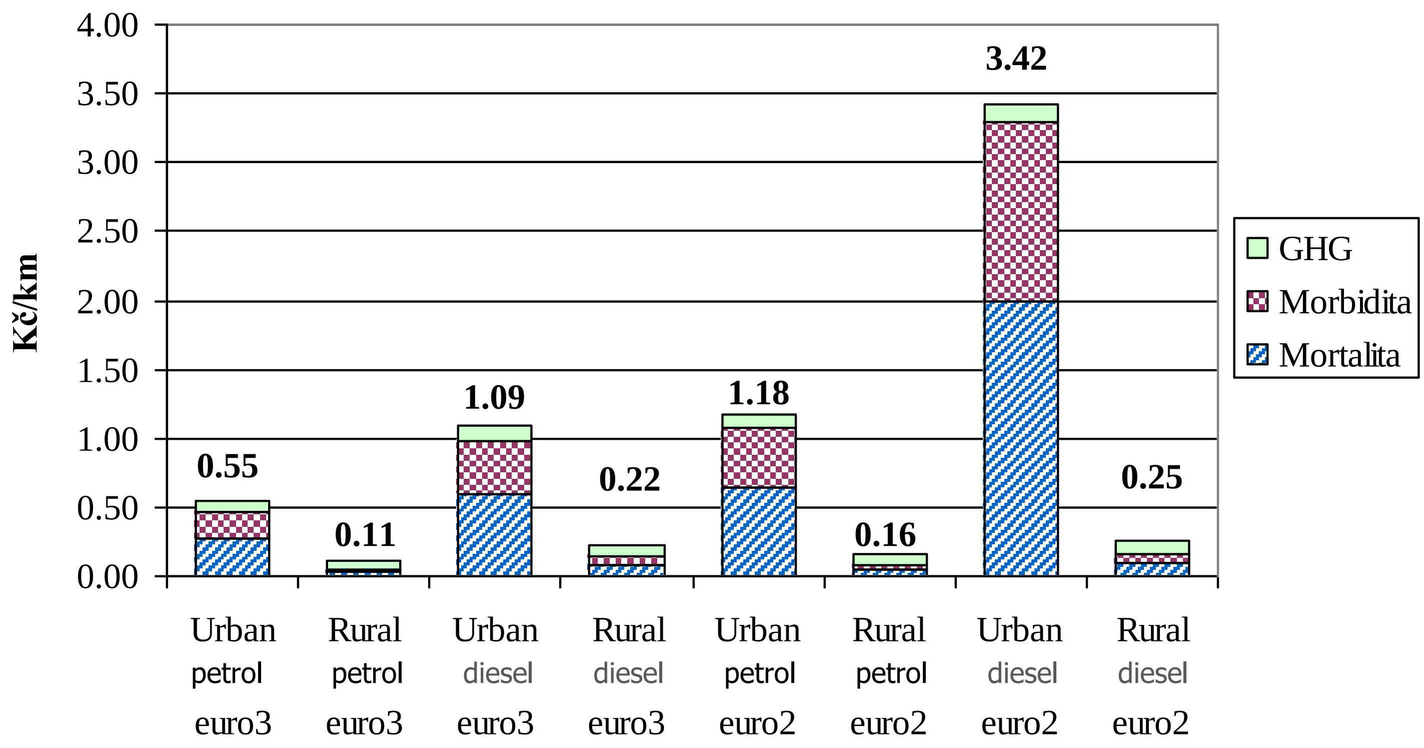


Source: CASES Project 2008.

Applications

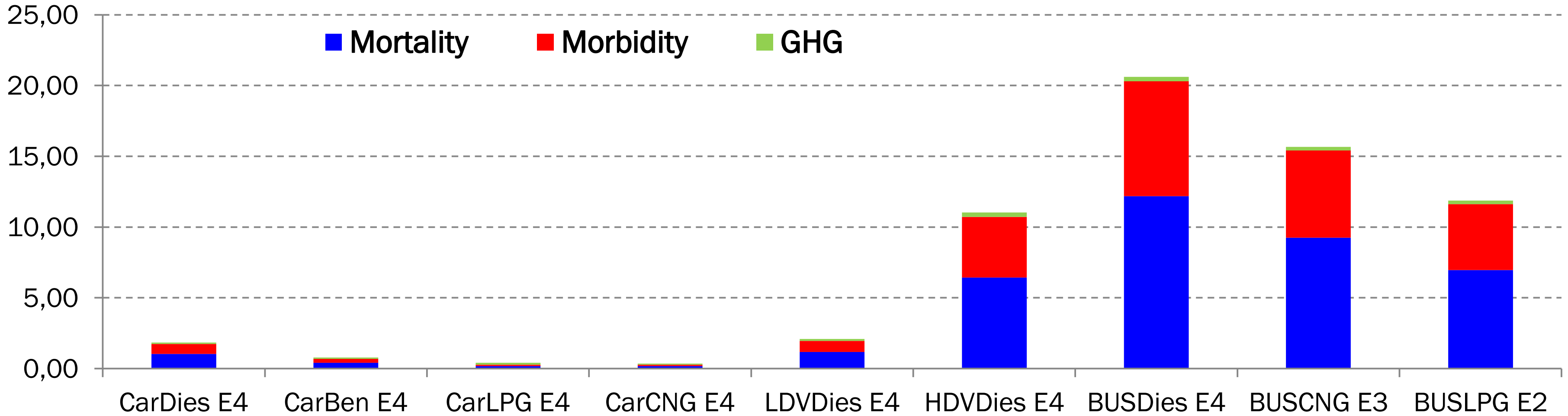
External Costs of Transport

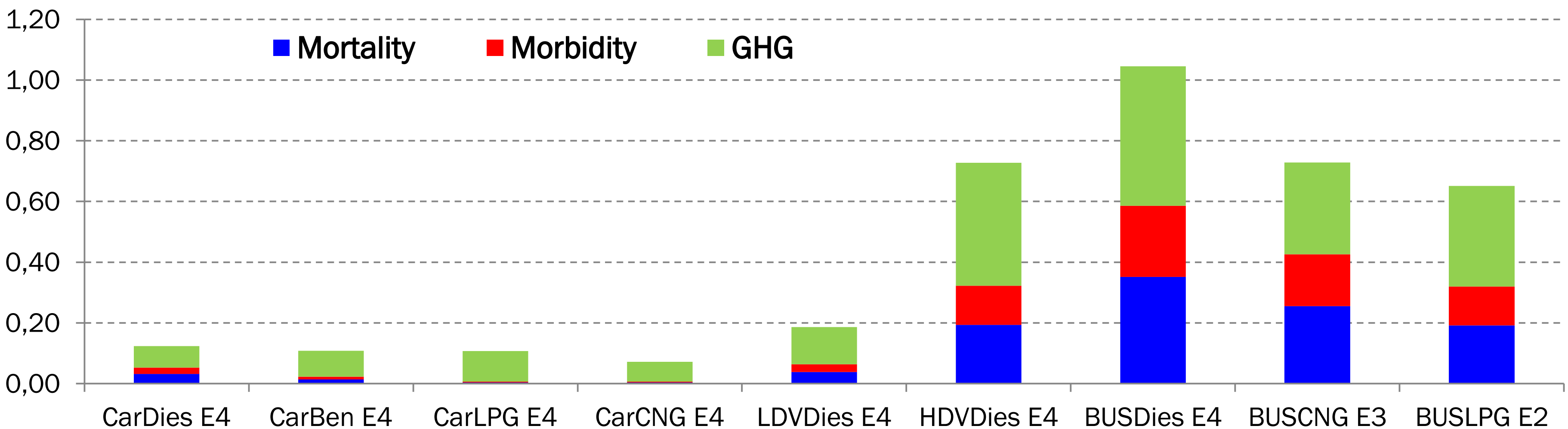
passenger cars, in CZK per km



Applications: External Costs of Transport

External costs in CZK/vkm (2008) per damage category in metropolitan area (above) and rural (below) area

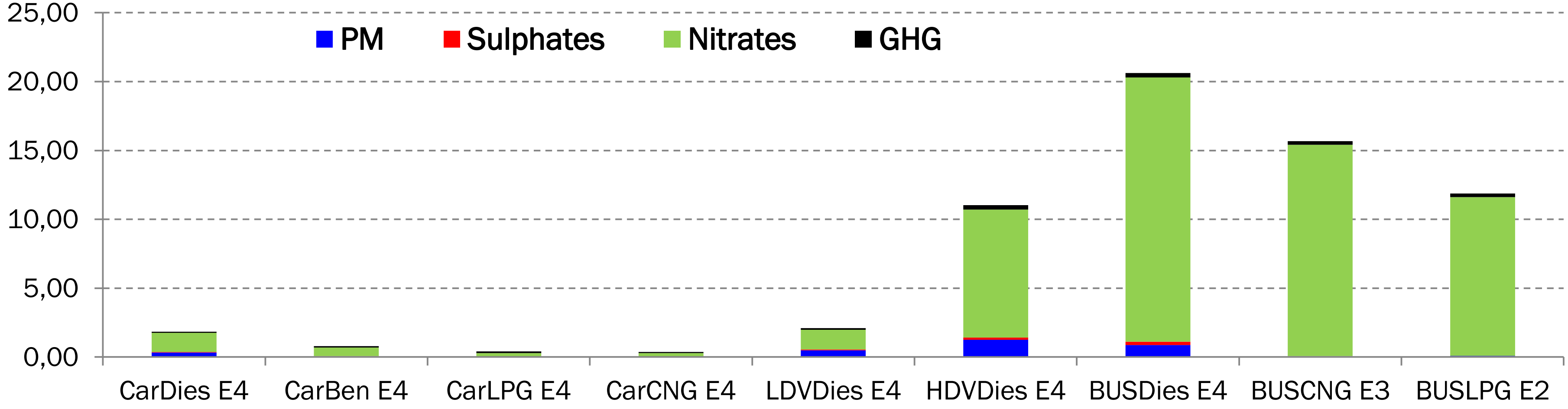


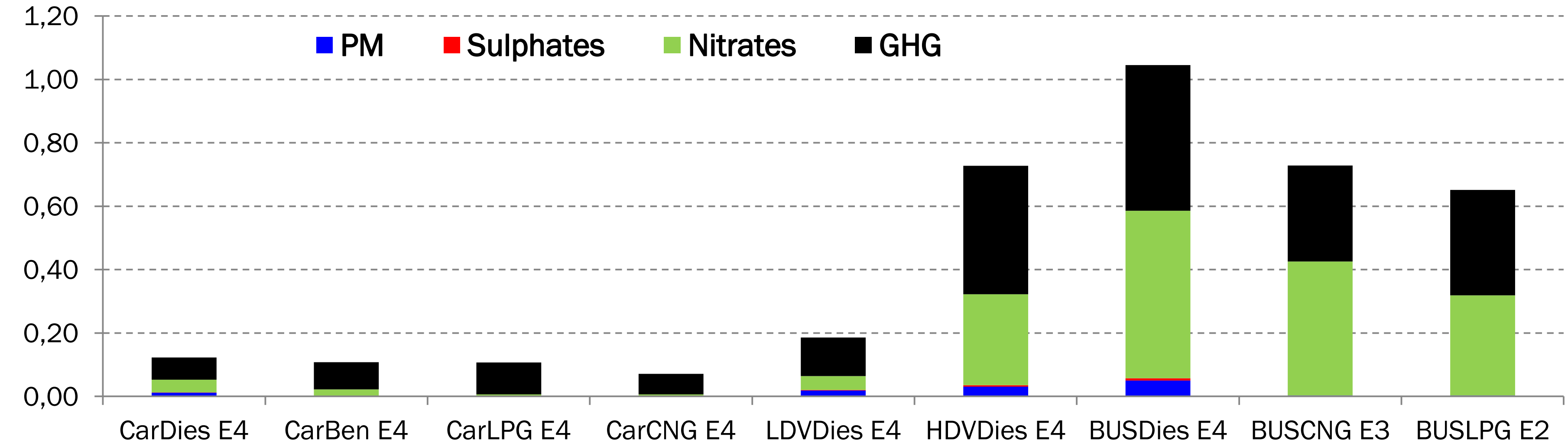


Source: Melichar and Máca (2010)

Applications: External Costs of Transport

External costs in CZK/vkm (2008) <u>per pollutnat</u> in metropolitan area (above) and rural (below) area

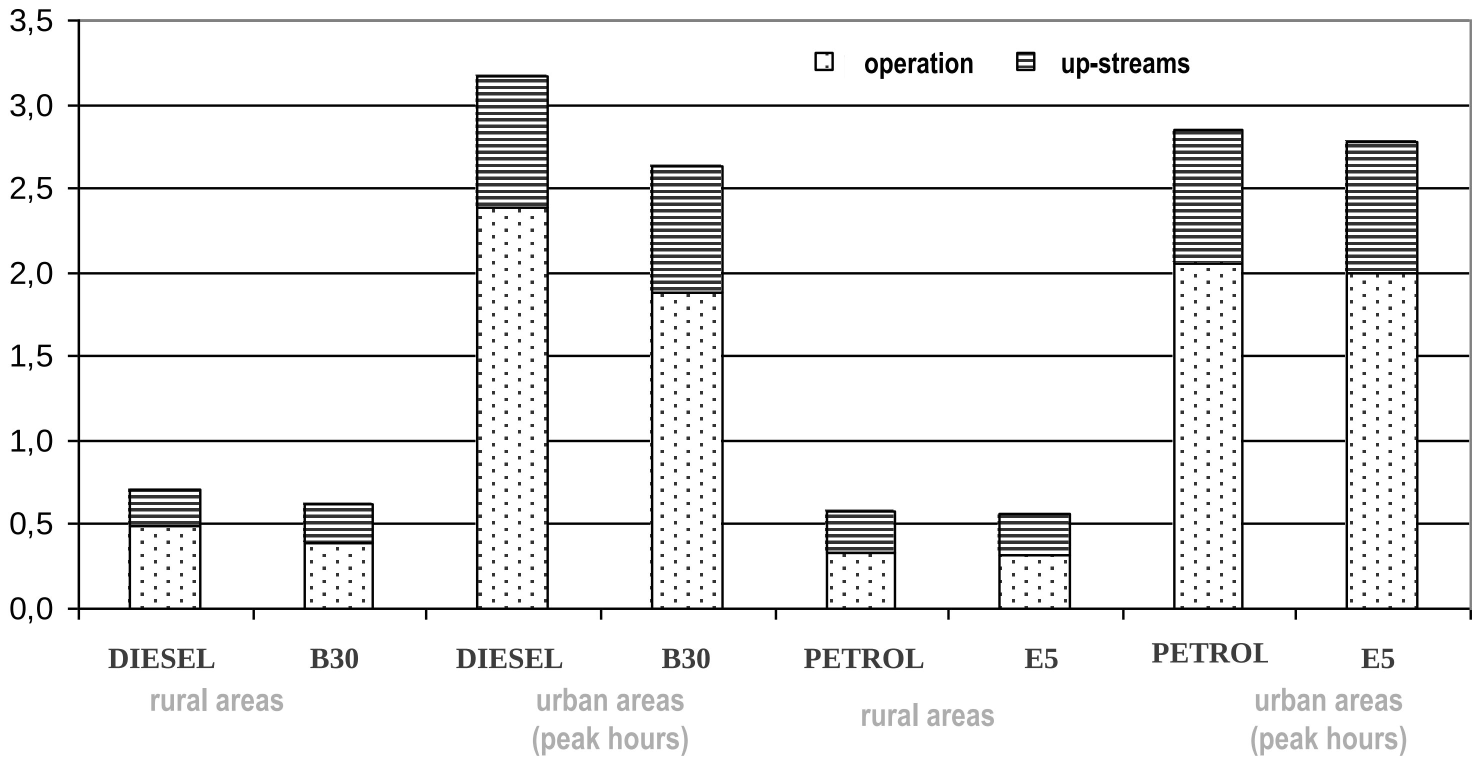




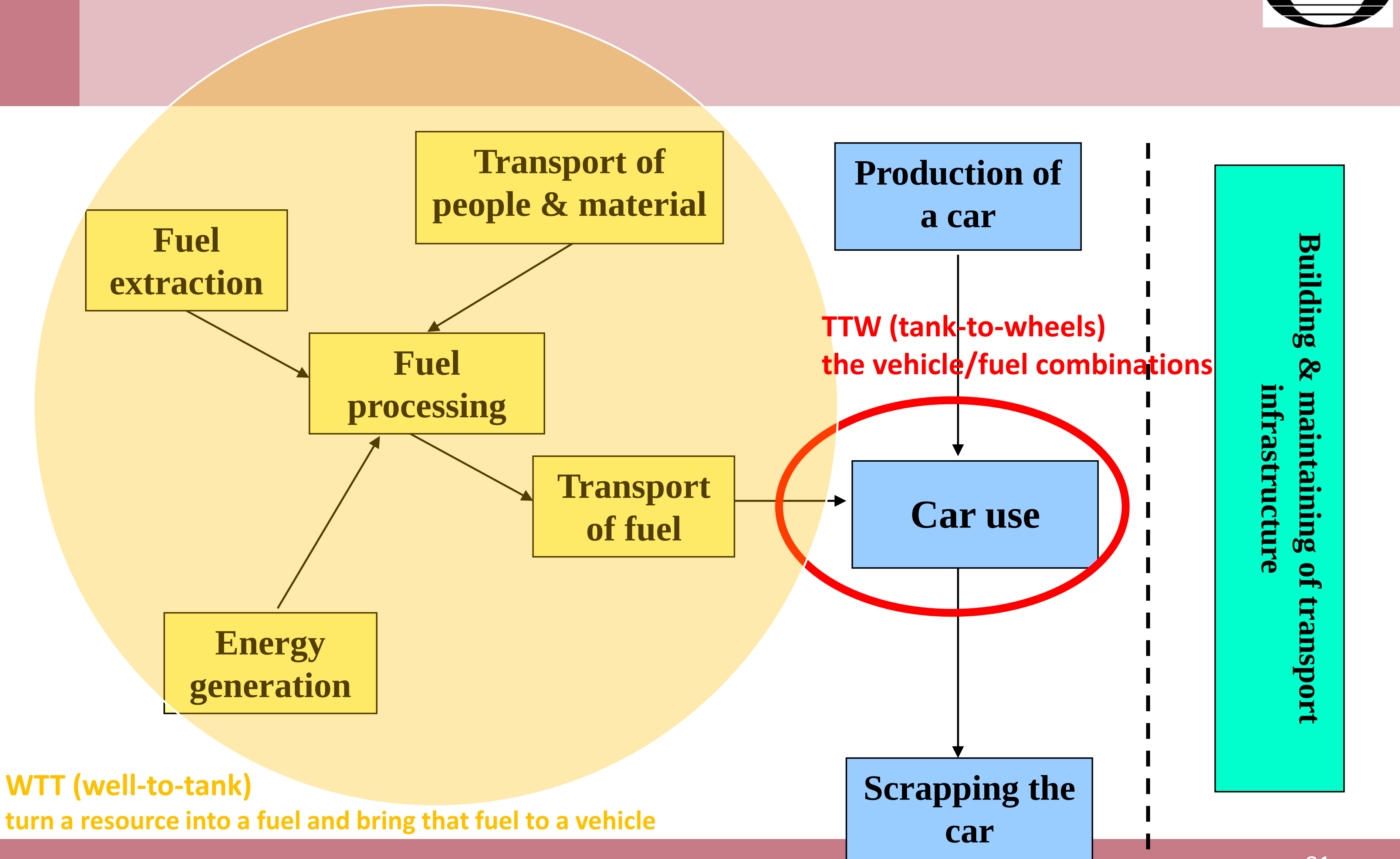
Source: Melichar and Máca (2010)

Applications
External Costs of Transport
passenger car EURO III 1.4-2.0 l, in €/100 vkm

Note: B30 - 30% biodiesel from rape; **E5** – 5% bioetanol from wheat



Fuel cycle for transport



Our approach in DEFINE
Electricity generation

- **Take emission from the PE energy model**
- **Use default damage values per country of emission releases for**
  - NOx, SO2, PM2.5, PMcoarse, NMVOC, NH3, trace pollutants, GHGs
  - as aggregate or per main impact categories
- **Run the EcosenseWeb tool, in collaboration with Charles University Prague, to quantify the impacts for a few power plants**
  - for the pollutants as above, but for more impact categories and including regional distribution of the impact
- **Assess benefits over study time**
  - if needed, conduct benefit transfer

Our approach in DEFINE
Electricity generation II

- **If emission is not endogenous variable in the energy model**
  - base the assessment on energy output per technology and actual emission-coefficient per technology
  - assume a trend in the emission-coefficient over time
  - derive emission per year implicitly

- **Use default damage values per country of emission releases for, or run the EcosenseWeb tool for a few power plants**

- **Assess benefits over project time…**

Our approach in DEFINE
Electric vehicles

- **Replacement of non-electric by electric → avoided external costs**
- **Take emission from WP5, i.e. the emission intensity per technology multiplied by the stock of given technology**
  - **well-to-tank:** non-electric YES, electric NO (incl. in electricity generation impact)
  - **tank-to-wheel:** non-electric YES, electric NO (no emissions)
  - **non-environmental TTW:** ignore (the impact does not vary across technologies)
  - **down-stream impacts:** ignore (the impact does not vary across technologies)
  - **transport infrastructure:** ignore (the impact does not vary across technologies)
- **Impact assessment then same as in the case of electricity generation, but**
  - **if detailed information about vehicle use is available, for instance use in urban vs. rural areas, damage assessment can take that into account**
  - **avoid double-counting**

Our approach in DEFINE

Electric vehicles: scope?

Resource \ Fuel		Gasoline, Diesel, Naphtha (2010 quality)	CNG	LPG	Hydrogen (comp., liquid)	Synthetic diesel (Fischer-Tropsch)	DME	Ethanol	MT/ETBE	FAME/FAEE	HVO	Methanol	Electricity	Heat
Crude oil		X												X
Coal					X(1)	X(1)	X					X	X	
Natural gas	Piped		X		X(1)	X	X					X	X	X
	Remote		X(1)		X	X(1)	X(1)		X			X	X	X
LPG	Remote(3)			X					X					
Biomass	Sugar beet							X						
	Wheat							X	X					
	Wheat straw							X						
	Sugar cane							X						
	Rapeseed									X	X			
	Sunflower									X	X			
	Soy beans									X				
	Palm fruit									X	X			
	Woody waste				X	X	X	X				X		X
	Farmed wood				X	X	X	X				X	X	X
	Organic waste		X(2)										X	X
	Black liquor				X	X	X					X	X	
Wind													X	X
Nuclear													X	X
Electricity					X									

Source: JRC, CONCAWE, EUCAR (2011: 14)

Our approach in DEFINE

What is NOT included in our impact assessment

Electricity generation

- Impact, so far, not covered by the ExternE
- some impacts, such as effect due to transmission lines, energy security might be discussed (based on literature review)

Use of vehicle

- dispersion of emission released from non-electric vehicles
- down-stream effects (is scrapping an e-vehicle relatively more damaging?)
- up-stream externalities (production of a vehicle)?
- non-environmental benefits, such as congestion, traffic accidents, noise annoyance

Input requirements

- **Inflows from other WPs; per year and per country (DE, AT, POL)**

  - **Electricity generation**
    - **emissions per kWh, or**
    - **kWh output per technology, but the emission-coefficients (t per kWh) over time need to be carefully examined**

  - **Vehicles**
    - ***vehicle stock* per technology**
    - ***emission parameters* per technology (TTW + WTW)**
    - ***ideally, use* of each technology in urban and rural areas**

Input requirements
Brief review

- **Brief review of other WPs**
  - WP4: development of the vehicle stock in Austria and Germany up to 2030 for different scenario, month 14 [but not for Poland]
  - WP4: energy demand of the transport sector and additional electricity demand generated by electric vehicles up to 2030, month 14 [is Poland included in WP10?]
  - WP5: calculation of the emissions (covering GHGs, CO, NOx, particles, SO2, N2O), month 25 [but not PMs]
  - WP5: Emission reduction potential for GHG emissions and air pollutants in Austria and in Germany up to 2030 (month 25) [but not for Poland]; UBA has access to the expert version, presenting the most recent vehicle emission data in Europe [including Poland?]

- **Other sources**
  - JRC-CONCAWE-EUCAR 2011 Reports (version 3c)
  - MEFA db CZE
  - TREMOVE

WP9 outputs

External costs

- benefits (avoided damage) expressed in monetary terms (e.g. Euro 2000)
- however, most impacts are non-market goods → are outside of national accounts and thus not included in SAM

Soft-link

- **environmental benefits** → **macro model of the economy**

  (damage per ton of emission) *(emissions is endogenous variable)*

  (damage per kWh per technology) *(kWh per technology is endog.var.)*

- **environmental benefits** → **household's vehicle ownership model**

  (damage per vkm per technology) *(vehicle stock and vkm per technology)*

  (indirect damage per vkm per technology)

Timeplan

		2012								2013												2014									
		M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14	M15	M16	M17	M18	M19	M20	M21	M22	M23	M24	M25	M26	M27	M28	M29	M30
		May	June	July	Aug	Sep	Oct	Nov	Dec	Jan	Febr	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Jan	Febr	Mar	Apr	May	June	July	Aug	Sep	Oct
WP1&6	IHS+		WS1			WS2		top-down			WS3			bottom-up					WS4		calibr.				valid.		simul.				
WP2&7	DIW+ESEA	START													PEM structure data ready				valid					study							
WP8.2	CASE										START									WS				SAM enerdat			casestudy				
WP5	UBA+OEI															START						emission reduction potential in AT+DE									
WP9	CASE																		START								externality		softlink		

Thank you for your attention

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Task 8.2

- **Parameter of household demand for vehicles for macro model**
  - planned for month 24
- **Social Accounting Matrix for Poland**
  - IOT 2005 compiled by the Polish Statistical Office
  - IOT 2010 due the end of 2014
- **Data on the electricity and energy sectors of Poland necessary for scenario applications of the general equilibrium model (WP6/WP10)**
  - data available: generation capacities for specific techs, future energy mix, historic price and consumption of electricity, length and load of line capacity of Polish grid
- **Deliverable**
  - in month 24

Dis-aggregation of extermality

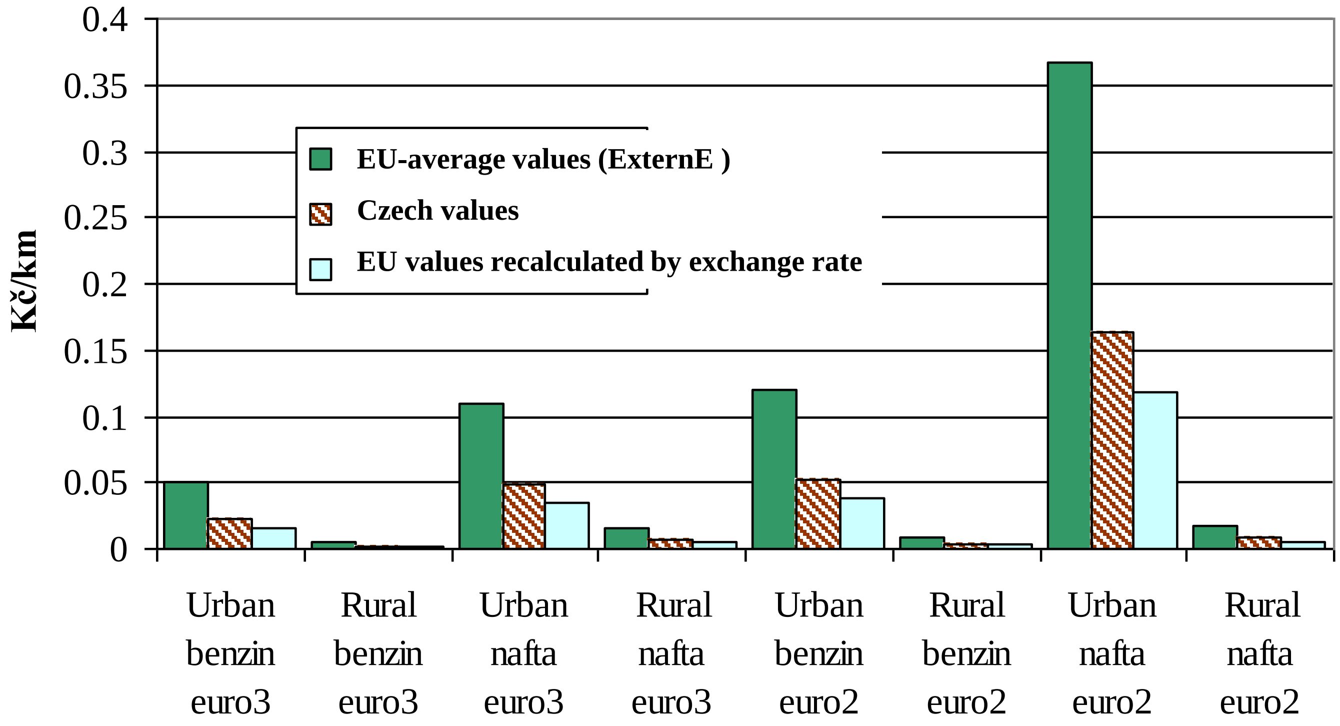
Ex.: Health effects of power sector in CZE

	Number of cases	mil. Euro	Percent of damage
'Acut' YOLL	17	1.02	0.1%
'chronic' YOLL	23 681	947.43	65.7%
Bronchodilator adults	152 398	0.15	0.0%
Bronchodilator children	16 303	0.02	0.0%
Cardiac hosp.admissions	175	0.35	0.0%
Cases_Infant_Mort	3	8.30	0.6%
Cough	79 570	3.02	0.2%
Chronic bronchitis	750	150.07	10.4%
Lower resp. symptoms adults	1 324 790	50.34	3.5%
Lower resp. symptoms children	842 390	32.01	2.2%
LRS cough	13 690	0.52	0.0%
Minor RAD	1 399 710	53.19	3.7%
NetRAD	348 732	45.35	3.1%
Respir. HA adults65	15	0.03	0.0%
Respir. HA all	284	0.57	0.0%
Work loss days	506 120 *(≈2,300 manyears)*	149.27	10.4%
SUM		**1 441.63**	

Source: Charles University Environment Center

External Costs of Passenger Transport Technology, in CZK/km

Different social planner perspective on valuation of morbidity impacts



Source: Charles University Environment Center