Environment Center
Charles University
in Prague

Estimation of External Cost from Transport

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Ministry of the Environment
September 16th, 2010

Overview of state of the art

European research

- 4th, 5th, and 6th EU-framework programmes
  - **ExternE Core/Transport** (1999): Assessment of Energy-related Transport Externalities (Friedrich, R., Bickel, P. 2001: Environmental External Costs of Transport. Springer-Verlag)
  - **CAPRI** (1999): Concerted Action on Transport Pricing Research Integration
  - **RECORDIT** (2001): Real Cost Reduction of Door-to-Door Intermodal Transport
  - **UNITE** (2003): UNification of accounts and marginal costs for transport efficiency
  - **HEATCO** (2006): Developing Harmonised European Approaches for Transport Costing and Project Assessment
  - **GRACE** (2007) Generalisation of research on accounts and cost estimation
- **ExternE** website: www.externe.info
- EC (2008): Handbook with estimates of external costs in the transport sector summarizing the state of the art as regards the valuation of external costs
- INFRAS/IWW study (2004) : External costs of transport, IUR.
- National studies: Germany , UK, the Netherlands and Switz.

Czech research

- CUEC (2011): Quantification of external cost of transport in the CR
- UE (2010): Shadow prices of externalities in transport

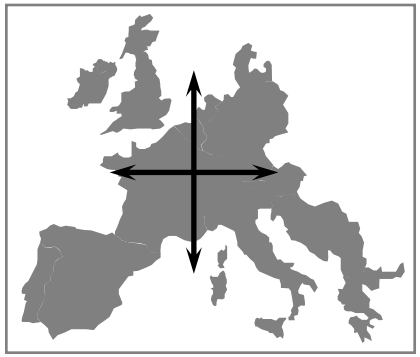
Methodology

1. We follow **ExternE methodology** (see European Commission, 1995, 1999, 2000, 2009, downloadable at www.externe.info)
2. Damages caused by pollutants are assessed using **bottom-up approach**, we use **impact pathway analysis**.
3. The amount of damage is determined by:
   - type of technology (vehicle, fuel, emission standard)
   - site of activity (urban, suburban, rural)
   - boundaries of analysis (range of fuel cycle, geographical elimination, time horizon, emissions)
   - values of affected population
4. Assessment of the relationship between effects (emissions) and physical damage is based on **concentration-response functions**
5. **Monetary valuation** is determined by the preferences of affected population
   - we use economic estimates of welfare changes
   - market prices (crops, building materials)
   - costs (biodiversity loss, cost-of-illness, climate change)
   - non-market values (mortality, morbidity, climate change)

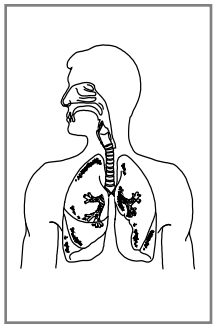
Impact pathway approach (IPA)

POLLUTANT & NOISE EMISSIONS

TRANSPORT & CHEMICAL TRANSFORMATION



DIFFERENCES OF PHYSICAL IMPATS



MONETARY VALUATION

The main characteristics of IPA

I.

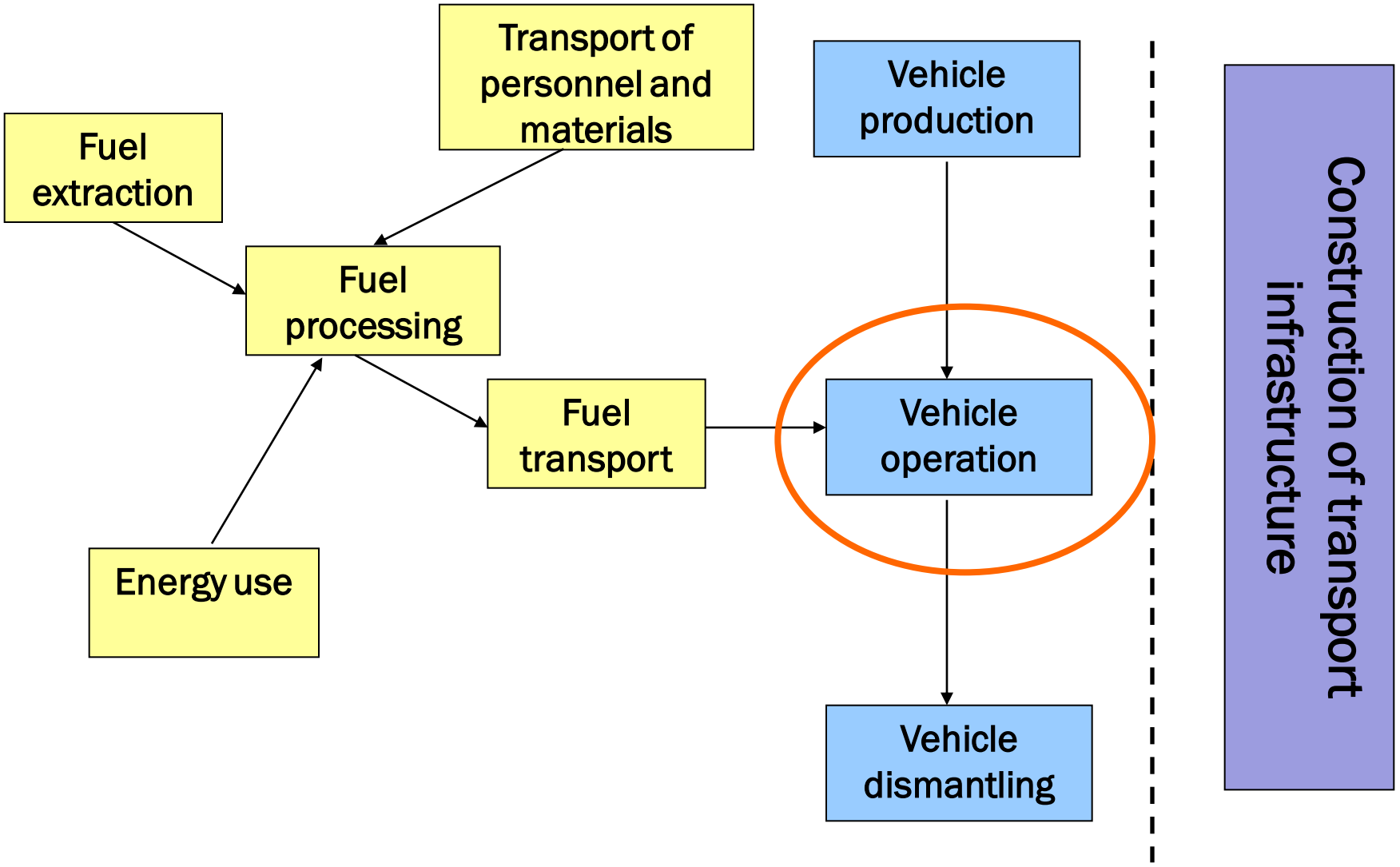
Dependence of external cost on **spatial specification**: local, regional and global level

II.

Reflecting **the whole fuel cycle** ⇒ up-stream and down-stream

… fuel extraction and transport, production, operation and dismantling of technology …

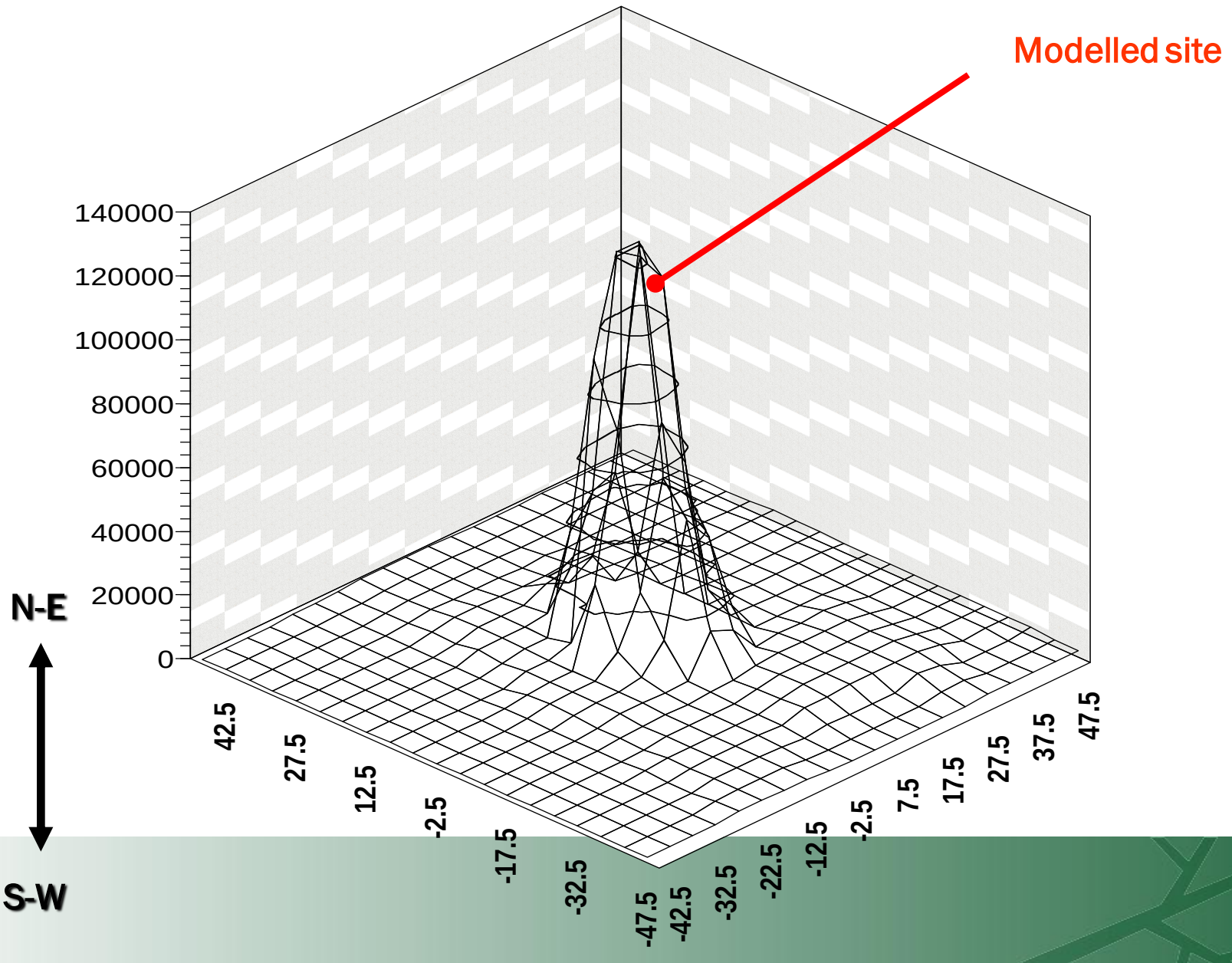
Structure of transport fuel cycle



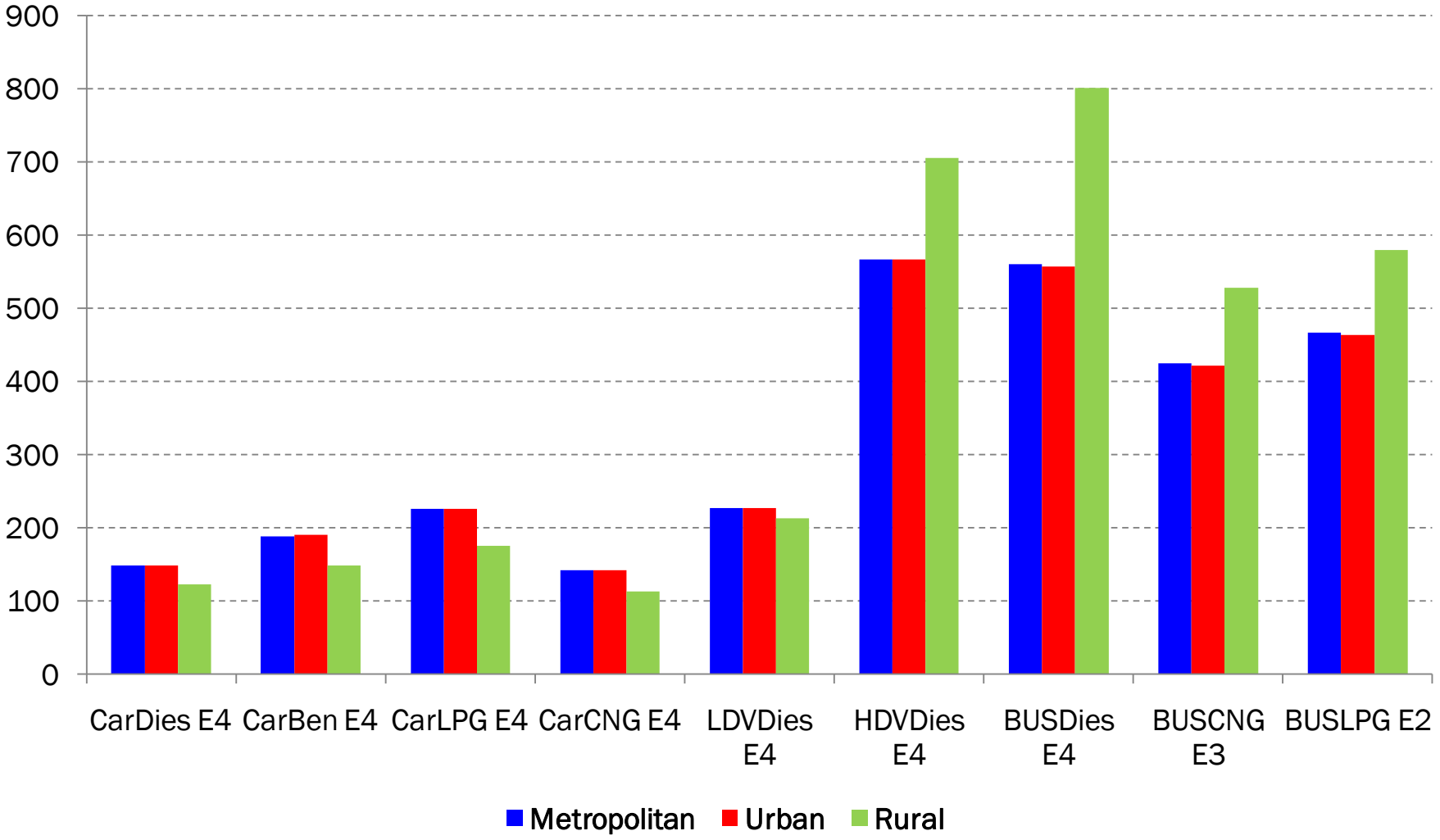
Case study: assessment of external costs

- **Road motor vehicles** - 27 scenarios
  - passenger car, light / heavy duty vehicles, bus
  - petrol, diesel, CNG, LPG
  - emission categories EURO 2-4
  - metropolitan / urban / rural location
- **Emission factors**
  - national emission factor database MEFA (Šebor et al., 2002)
  - metropolitan 40 km/h, urban 50 km/h, rural 80 km/h
  - 0% road slope
  - TREMOVE 2.32 and 2.44 (updated from MEET)
- **Modelling approach**
  - RiskPoll 1.51 software (Spadaro, 2004)
  - meteorological data - hourly values (temperature, wind speed and flow direction) – taken from automated immission monitoring (CHMI)
  - pollutants: SO_2, NO_X, PM_{10}, $CO_{2eqv.}$
  - assessed impacts: damage to health (mortality, morbidity) and climate change

Population density in Prague (grid 5 km × 5 km)



$CO2_{eqv}$. emission characteristic of vehicles assessed, in g/vkm



Concentration-response functions and values for PM_{10}

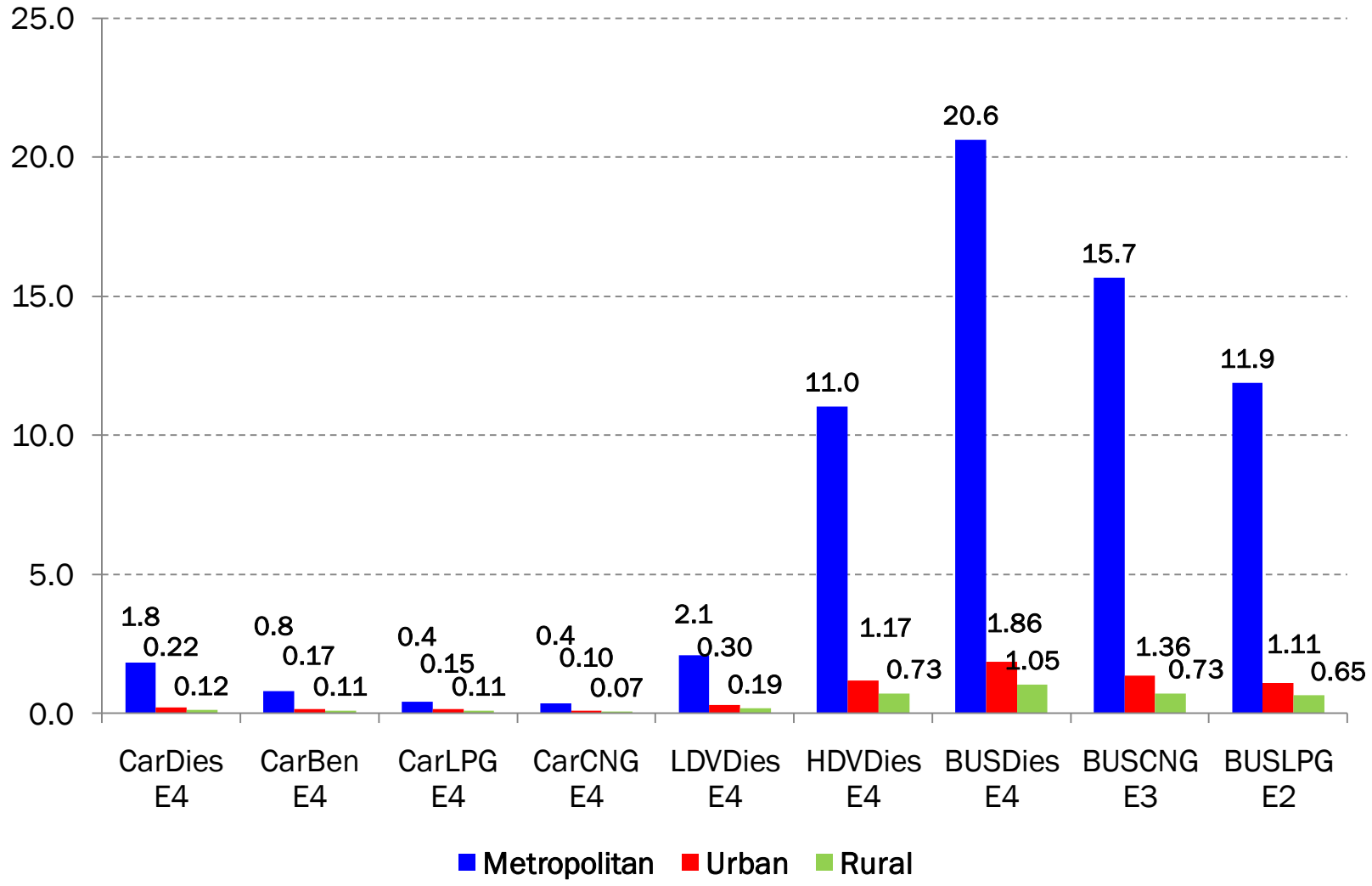
Concentration-response function	CR slope	Unit values (CZK 2008)
Mortality YOLL [Pope 2002]	2,90E-04	1 199 255
Chronic Bronchitis [Abbey 1995]	1,98E-02	3 898
Restricted activity days [Ostro 1987]	2,07E-06	59 963
Respiratory hospitalization [Dab 1996]	4,14E-04	1 139
Chronic cough, children [Dockery 1989]	2,59E-06	59 963
Congestive heart failure, elderly [Schwartz/Morris 1995]	9,39E-03	1 139
Cough, adult asthmatics [Dusseldorp 1995]	4,56E-03	30
Bronchodilator use, adult asthmatics [Dusseldorp 1995]	1,70E-03	1 139
Lower respiratory symptoms, adult asthmatics [Dusseldorp 1995]	1,87E-03	1 139
Cough, children asthmatics [Pope/Dockery 1992]	5,43E-04	30
Bronchodilator use, children asthmatics [Roemer 1993]	7,20E-04	1 139
Lower respiratory symptoms, children asthmatics [Roemer 1993]	3,92E-05	5 996 276

Valuing climate change impacts

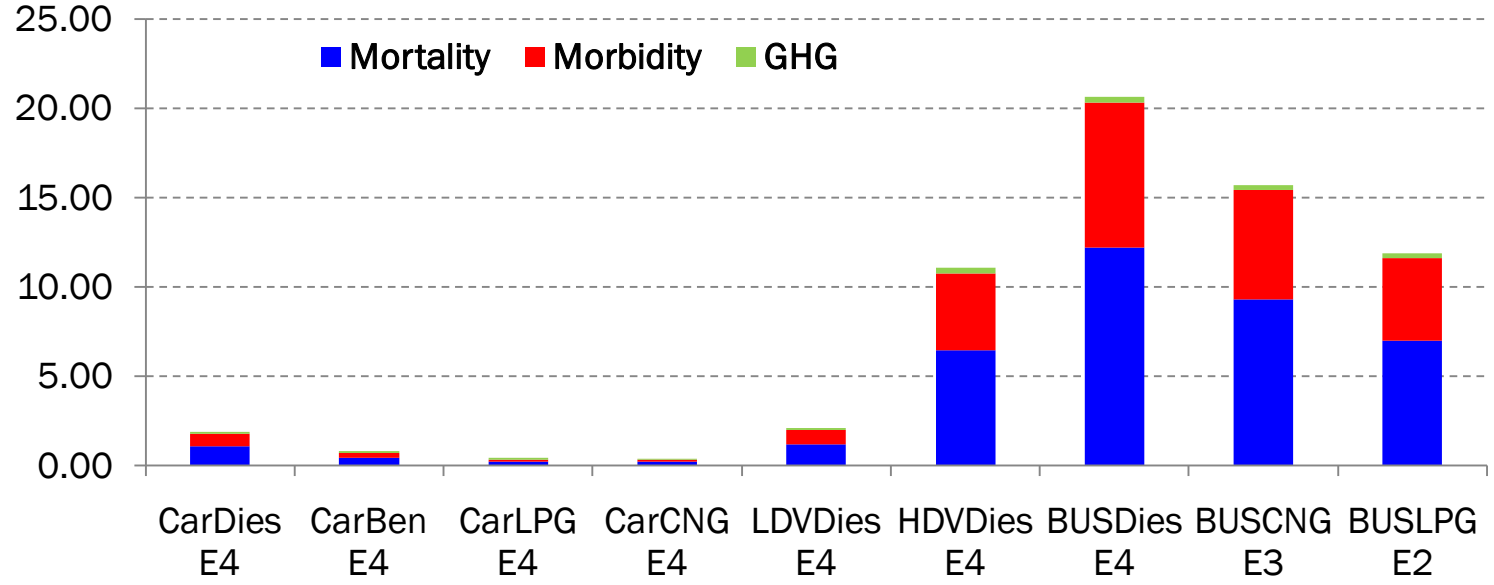
- **Market price** from carbon market (e.g. EU ETS € 14.19
- **Marginal Abatement Costs**
  - ExternE 23 €/tCO2: MAC for Europe for emissions reductions required by the Kyoto Protocol for the period 2008-2012.
  - Kuik, O. (2007): The Avoidance Costs of Greenhouse Gas Damage: A Meta-Analysis, CASES project, WP3, European Commission.
- **Social Costs of Climate Change**
  - Tol, R.S.J. (2005): The Marginal Damage Costs of Carbon Dioxide Emissions, Energ Policy, 33, 2064-2084.

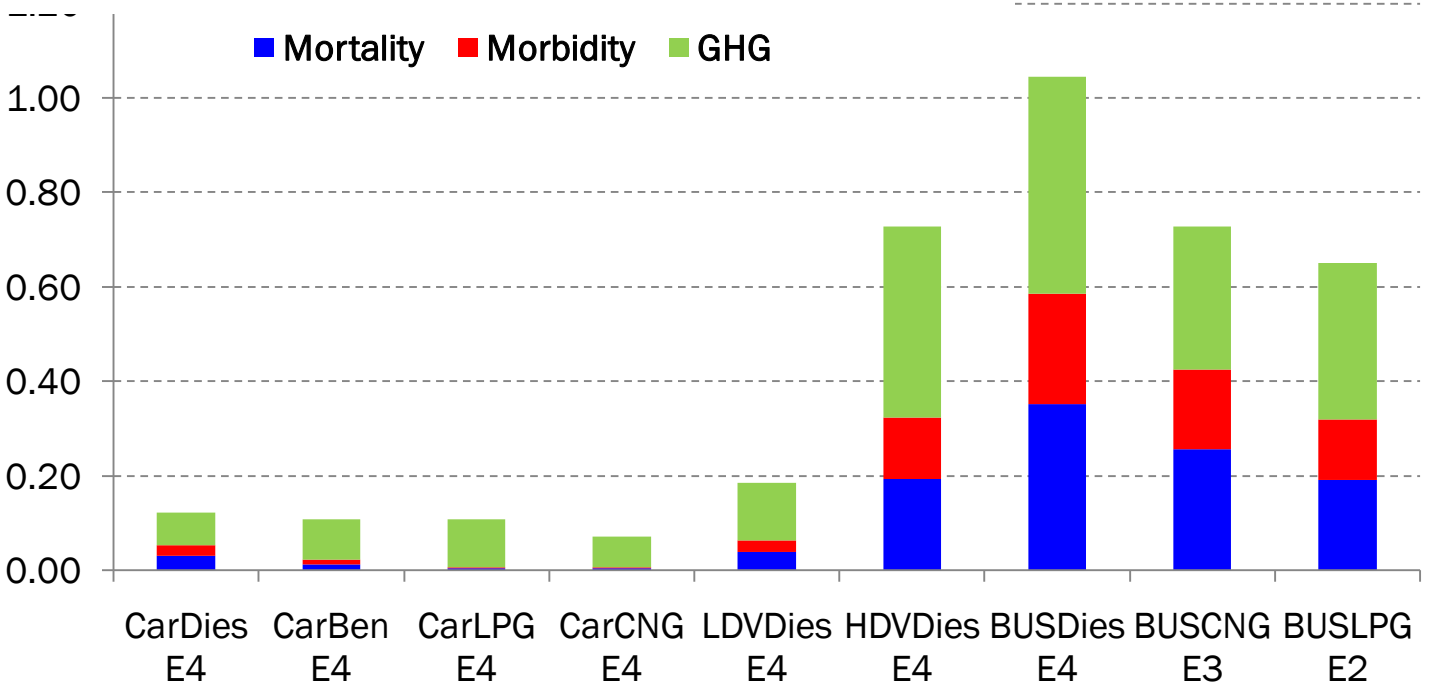
	$€_{2008}/tCO_2$	$€_{2008}/tC$	CZK_{2008}/tCO_2	CZK_{2008}/tC
EU ETS - June 2010	14		354	
MAC – ExternE value	23	84	574	2 095
MAC (Kuik 2007)				
mean 2025	24	95	599	2 370
mean 2050	63	250	1 572	6 237
median 2025	16	64	399	1 597
median 250	35	137	873	3 418
MDC (Tol 2005)				
mean	19	67	474	1 671
median	3	11	75	274

External costs of transport in the Czech Rep., in CZK/vkm (2008)

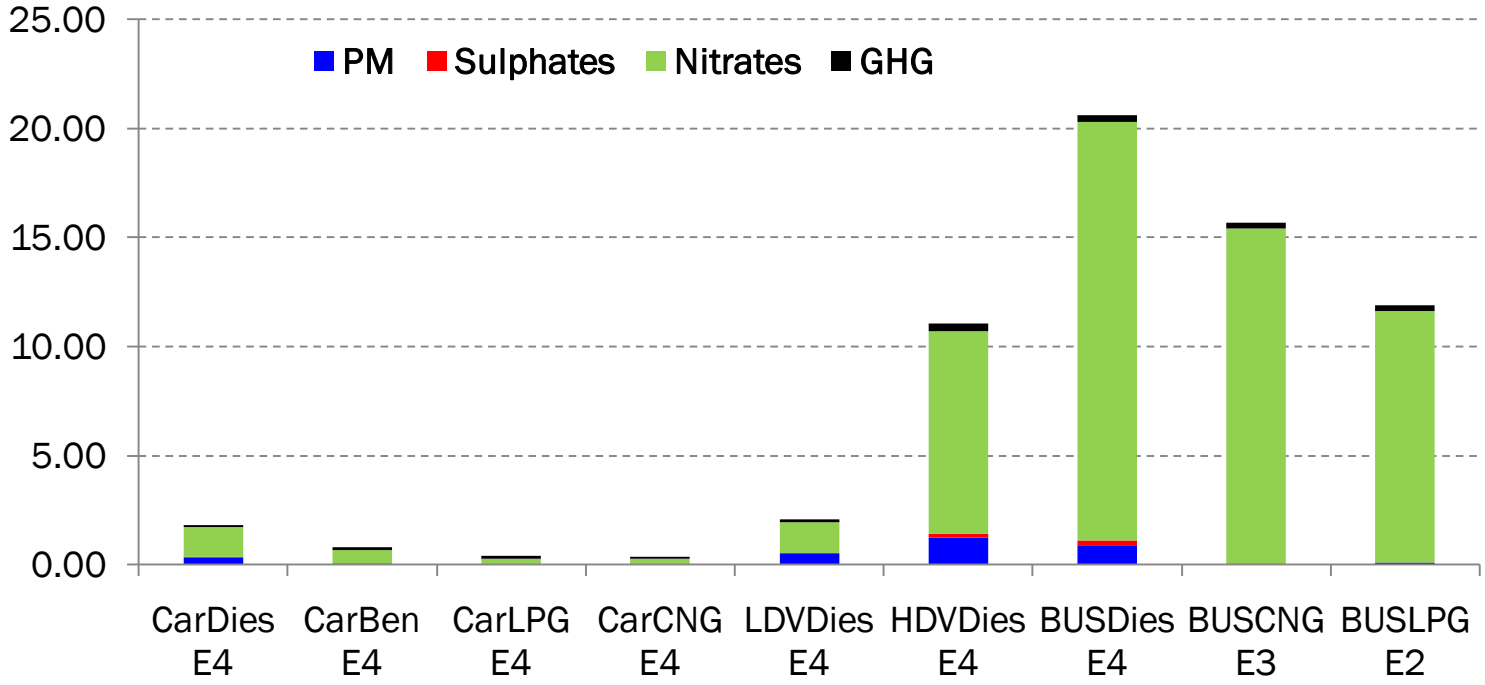


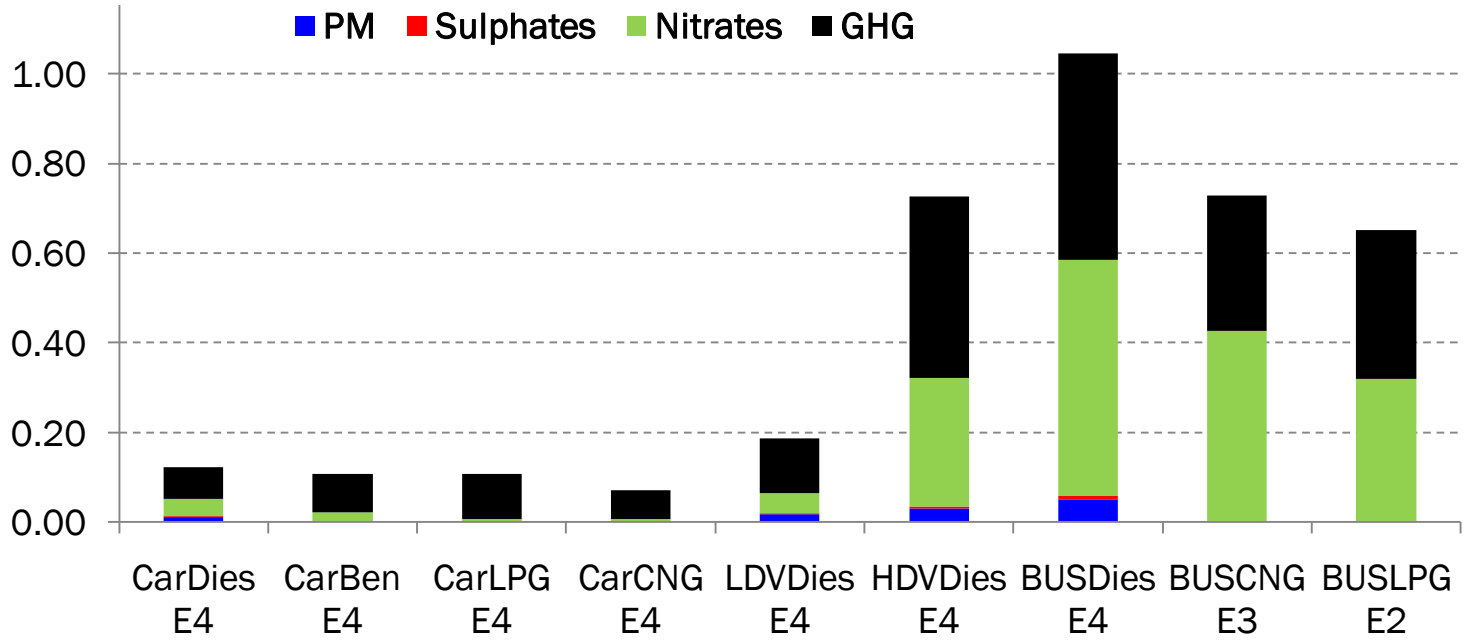
External costs according to damage category – metropolitan and rural area, in CZK/vkm (2008)



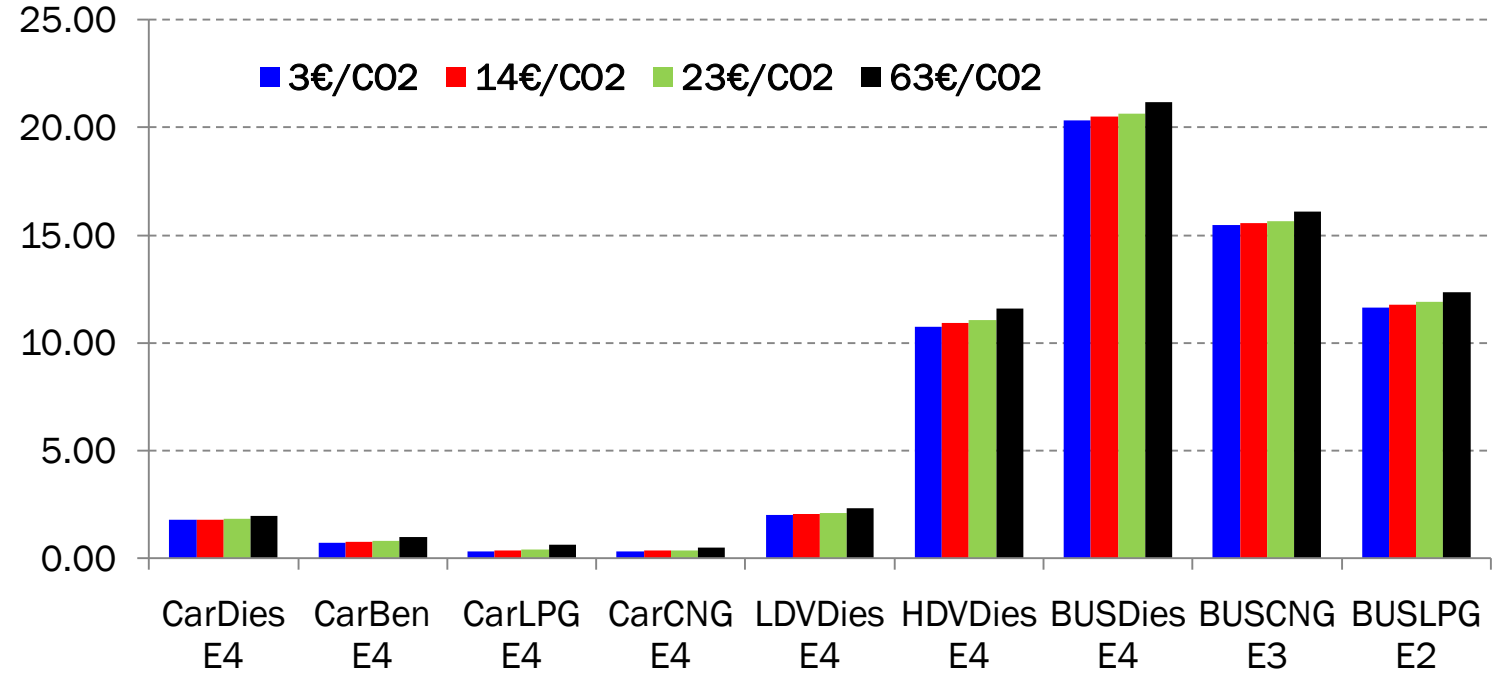


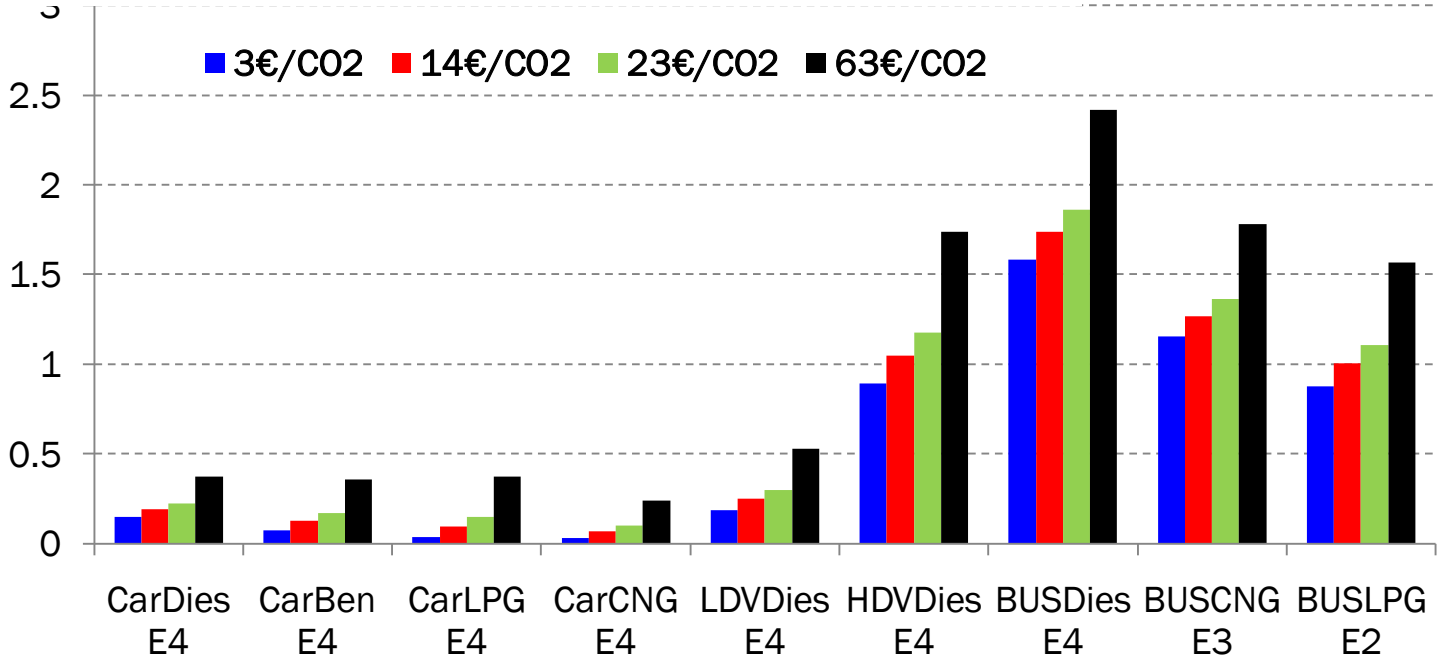
External costs according to pollutant– metropolitan and rural area, in CZK/vkm (2008)





External costs varying according to CO_2 value– metropolitan and rural area, in CZK/vkm (2008)





Discussion of the results

- LPG and CNG have the lowest impacts, mainly due to lower human health impacts, HDV and BUS have opposite effects $\Rightarrow$ one order of magnitude higher
- Results are sensitive to site specific parameters (e.g. population density $\Rightarrow$ the impacts in big cities are 7x and 13x higher then in small cities and rural areas respectively
- Mortality is the main impact in metropolitan area (54%), impact of GHGs are significant rural area (64%)
- Nitrates have the biggest impact in metropolitan area (81%), impacts of PM and sulphates are negligible, impacts GHG are highest in rural area
- The variability of CO_2 value is significant for the results in rural (€3 – 26%, €63 –81%) and urban area (€3 – 15%, €63 – 64%), effects in metropolitan area is lower (€3 – 1%, €63 – 20%),

Thanks for your attention!

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