Life cycle assessment of vehicles: critical comparison of available commercial databases

CHEMICAL ENGINEERING

PEPs – Products, Environment, and Processes

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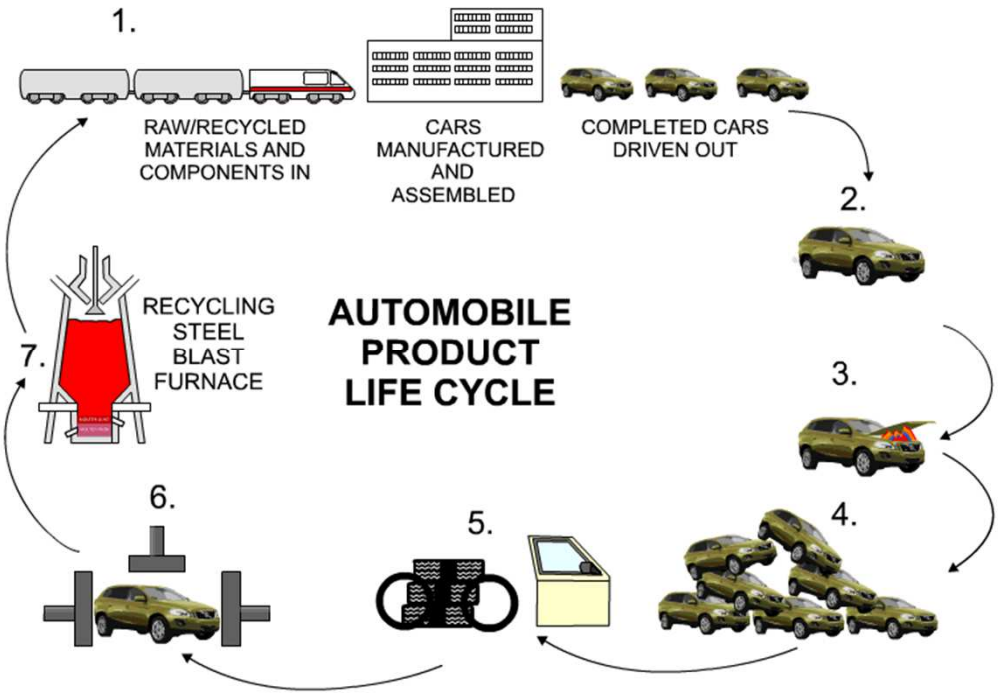
LCA: a standardized methodology

- General framework defined by international standards ISO 14040 - 14044
  - « studies all the environmental aspects and potential impacts associated with all the stages of a product's life from cradle to grave, i.e. from raw material extraction to end of life»
  - Product = product, activity, system or process



http://www.technologystudent.com/prddes1/carenviron4a.gif

Life Cycle Assessment: benefits

- LCA allows to
  - Identify key issues and avoid pollution trade offs with
    - The consideration of the global life cycle
    - The study of numerous environmental impacts on humans, environment, health and resources preservation

Quantitative

Multisteps

Multicriteria

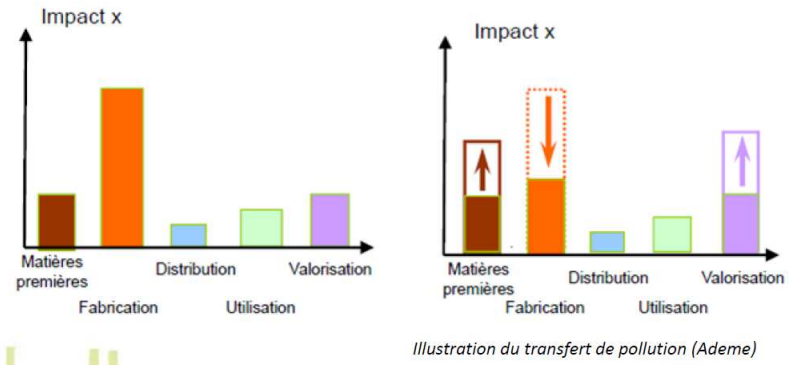
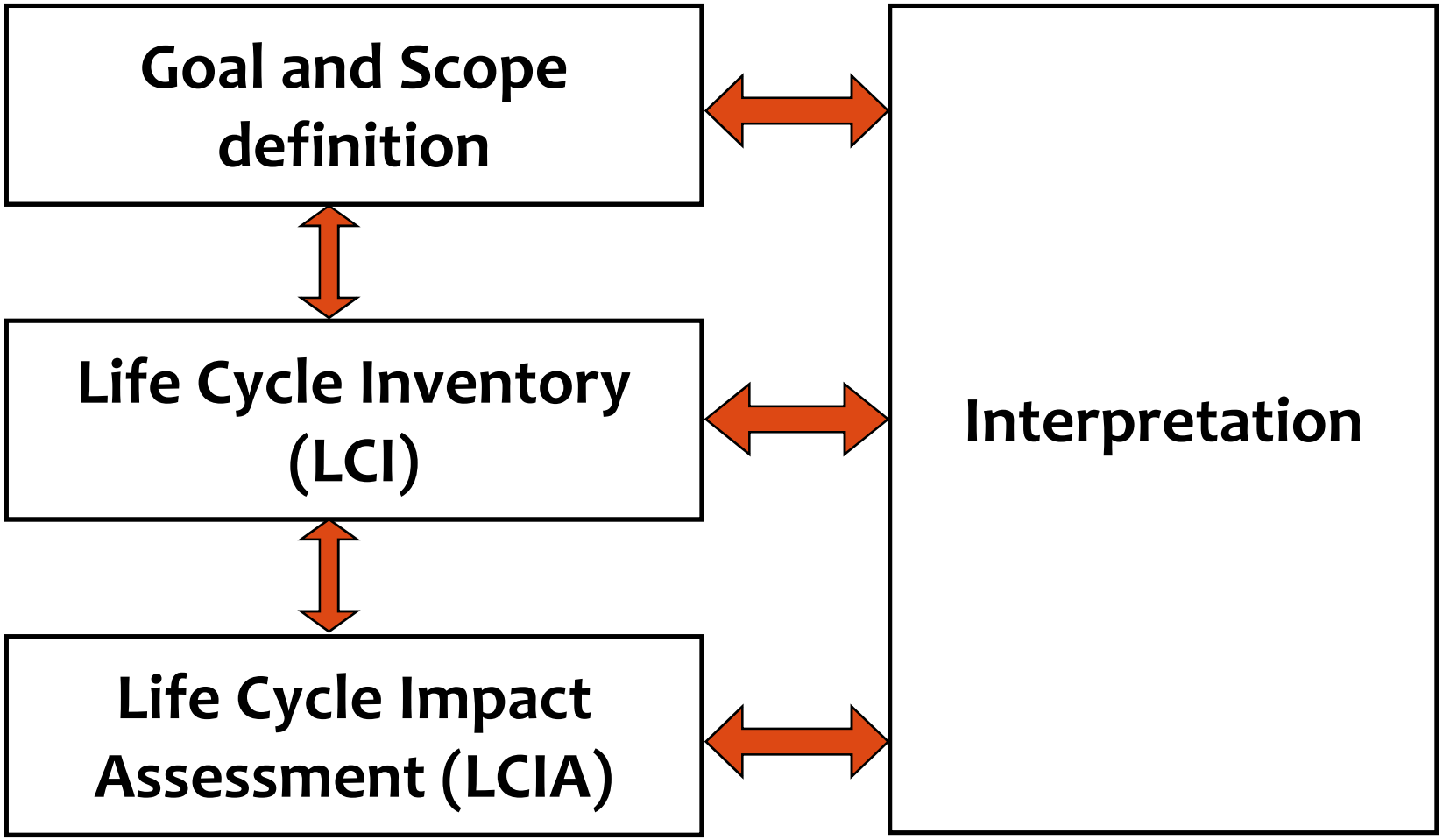


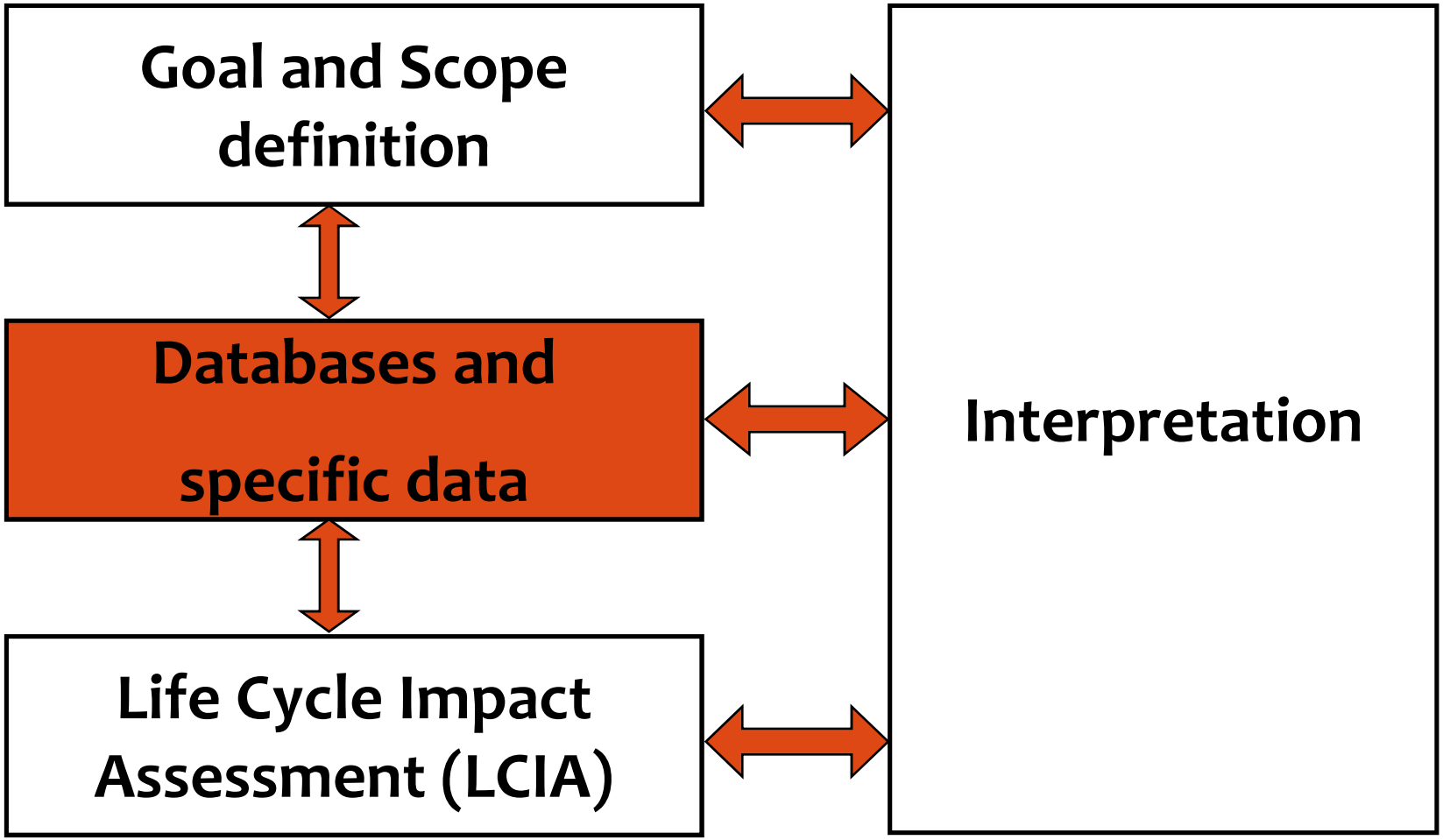
Illustration du transfert de pollution (Ademe)

  - Insure an objective comparison basis with the links between environmental pressures and the given function of the product/service

LCA in practice … 4 stages



LCA in practice … 4 stages



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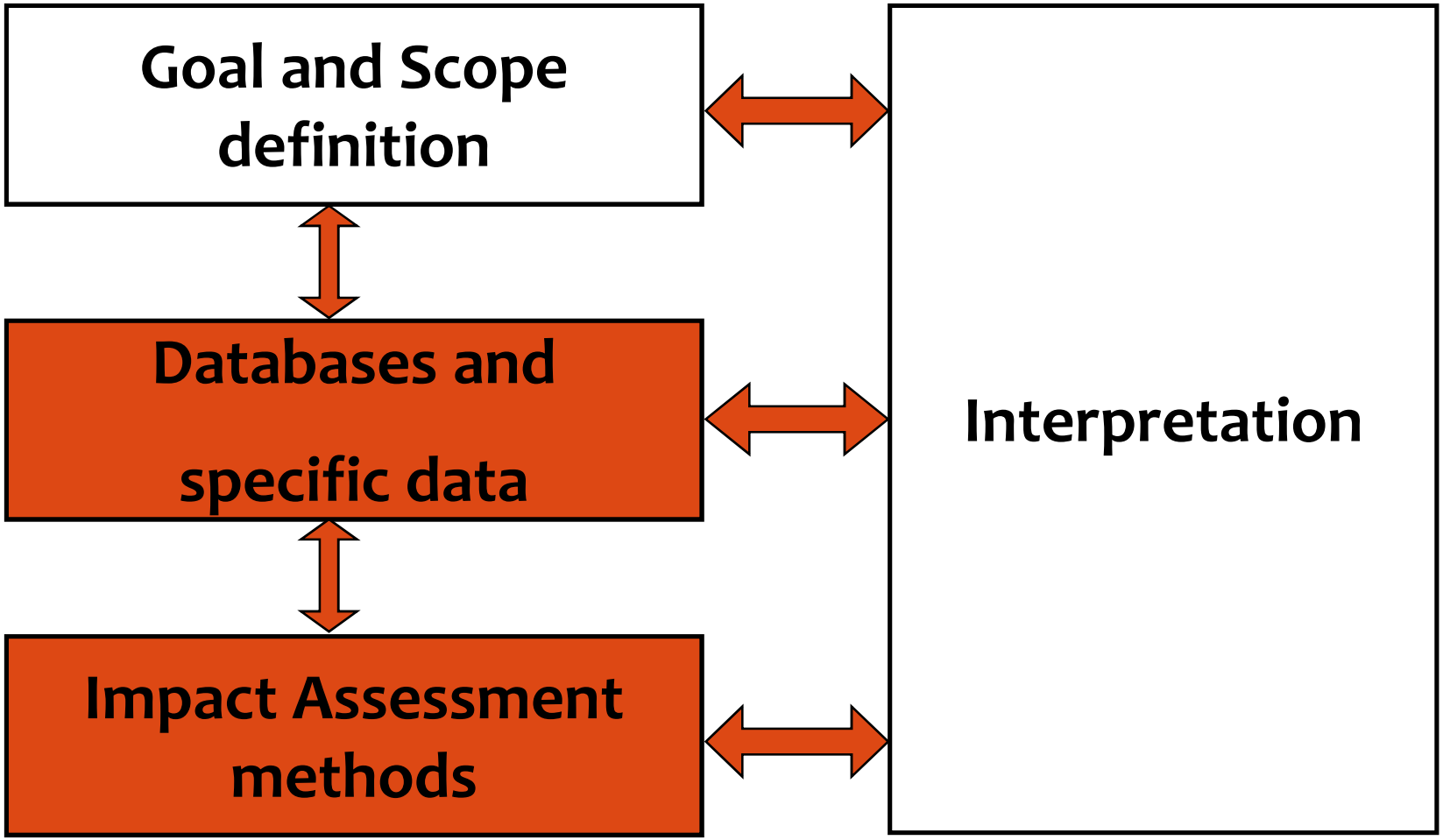
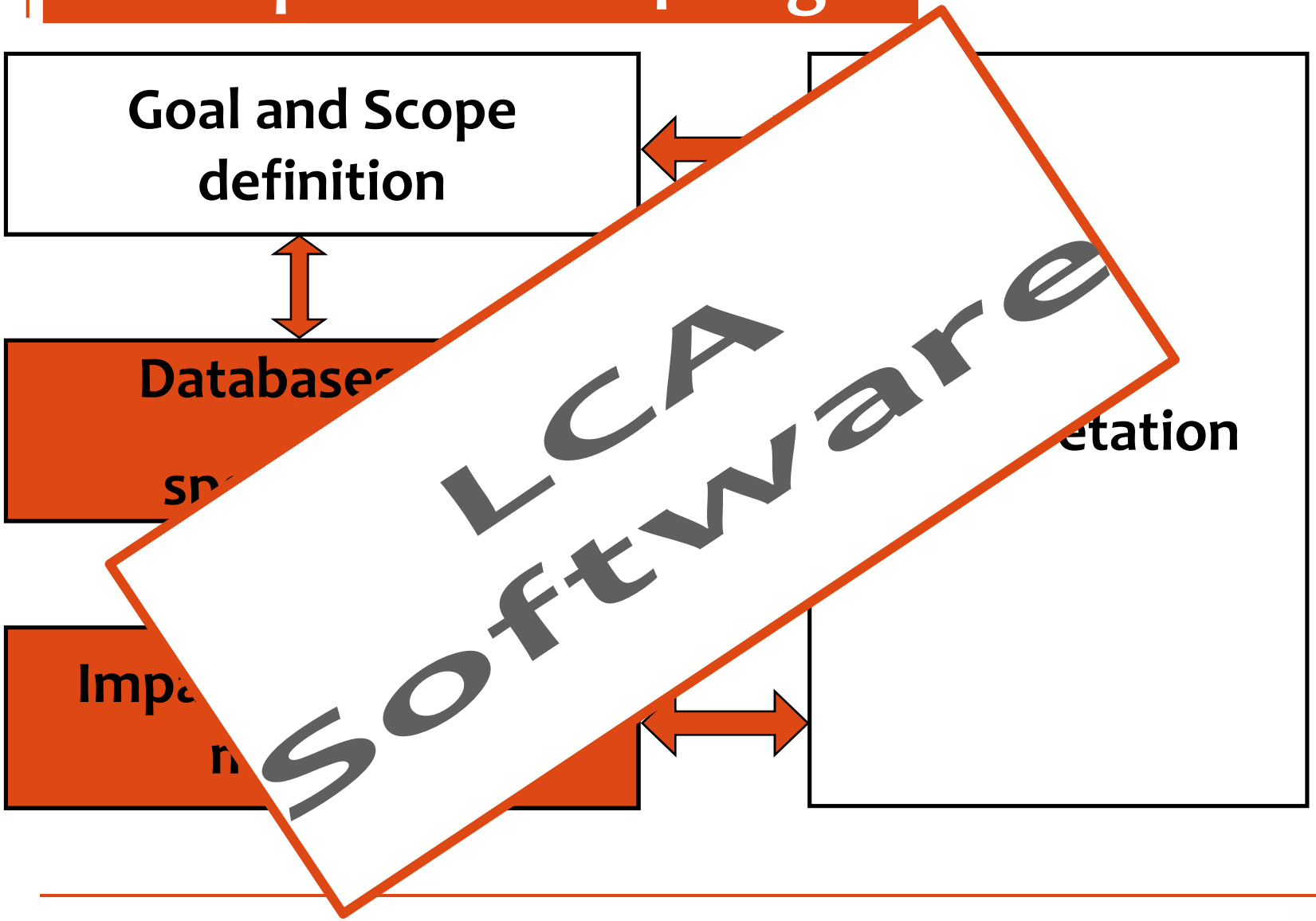


LCA in practice … 4 stages



LCA in practice

- Commercial and public databases
  - Ecoinvent
  - Gabi
  - ELCD
  - …

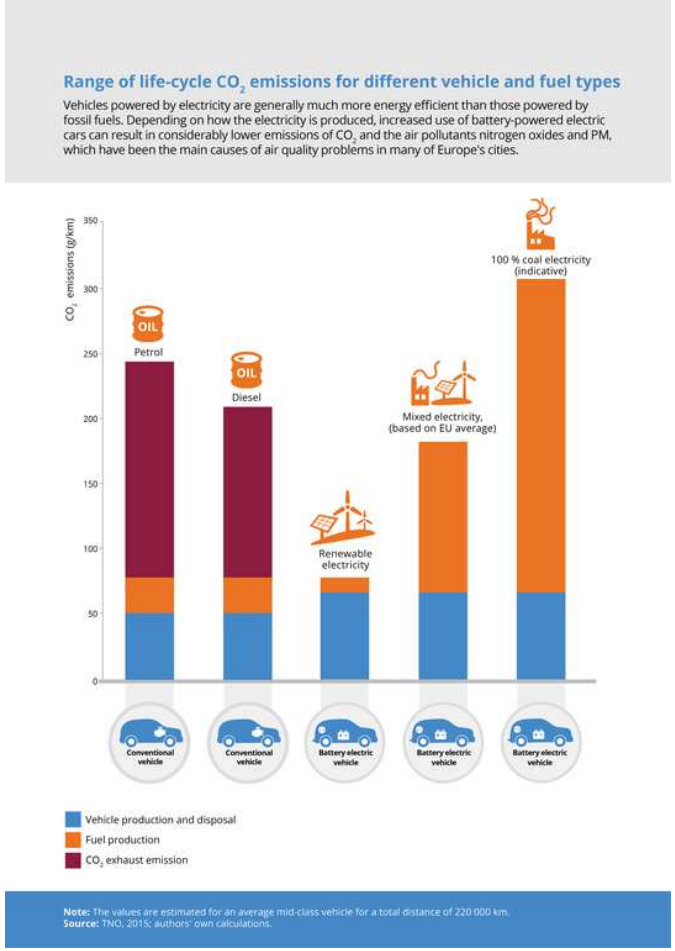
+ collect of specific data

- Recommended impact assessment methods
- Commercial and free softwares
  - Simapro
  - GaBi
  - OpenLCA
  - …

About vehicles

The approach …

- Lots of controversy when comparing vehicles



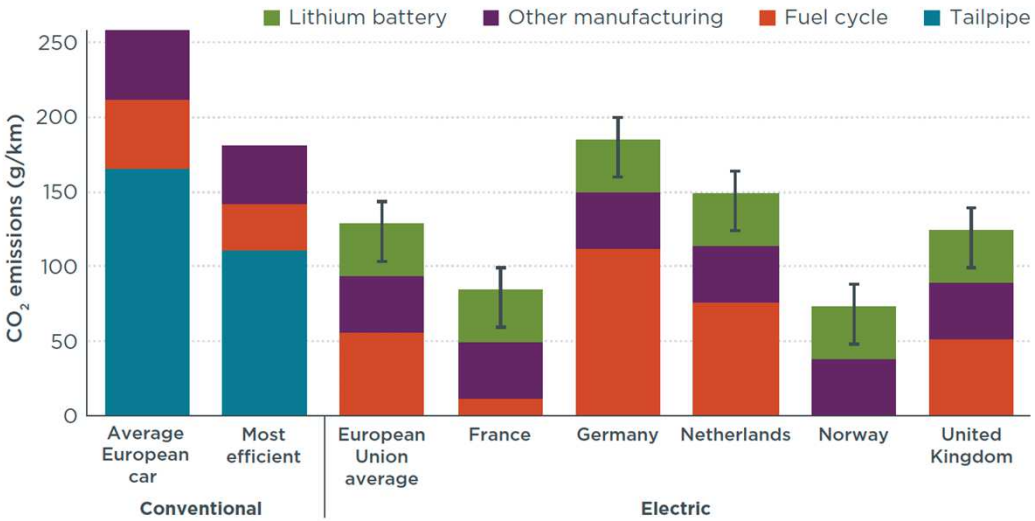


Figure 1. Life-cycle emissions (over 150,000 km) of electric and conventional vehicles in Europe in 2015.

https://theicct.org/publications/EV-battery-manufacturing-emissions

https://www.eea.europa.eu

The approach …

- What is the available information in most used commercial databases ?
- No specific study but ‘academic exercise’
- Use of the sofwares and databases blindly as a ‘standard user’, not as an expert

Let’s push the button and see …

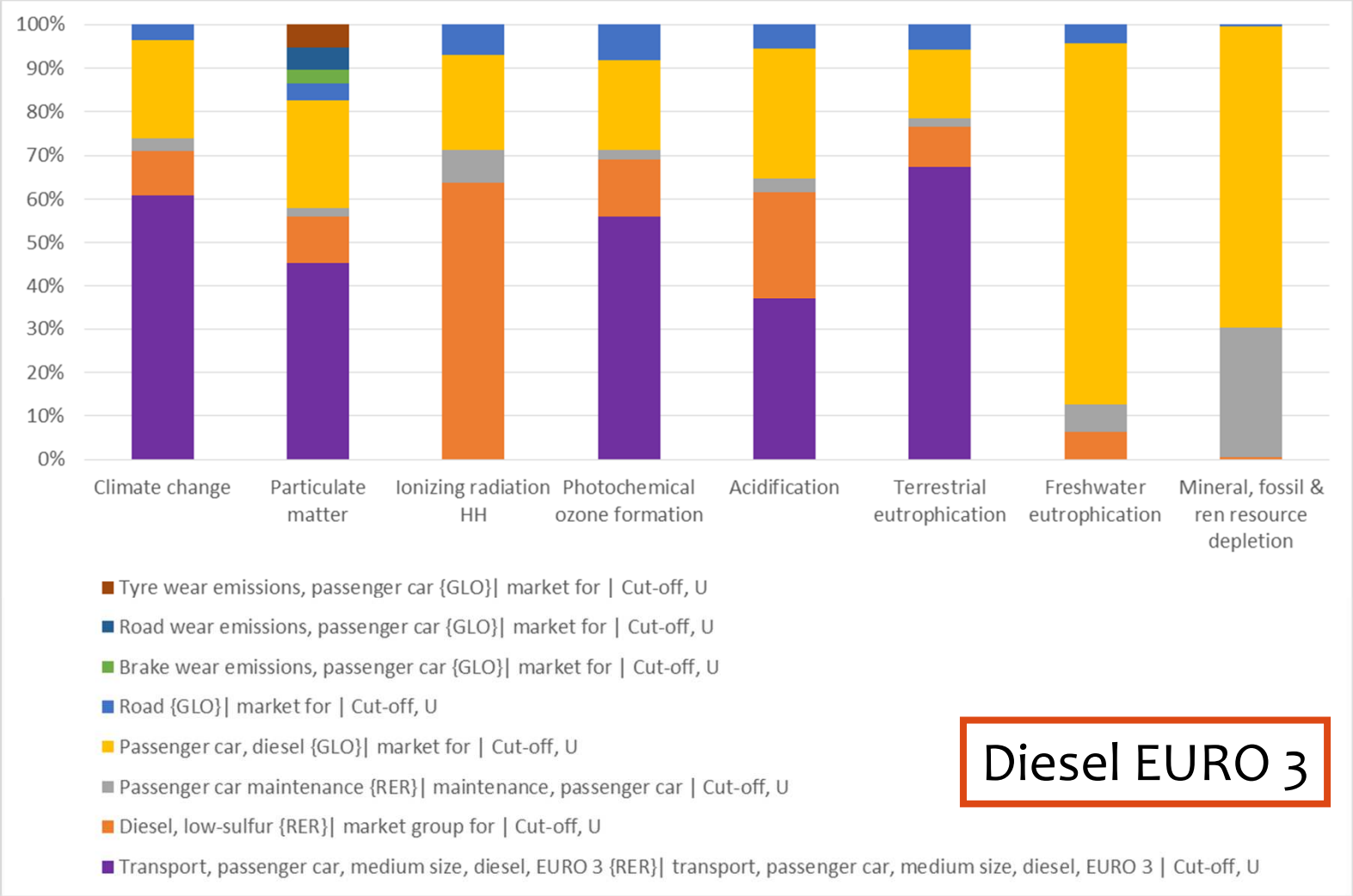
I will not tell you which is the best solution

Ecoinvent 3

- Passenger cars with
  - Increasing environmental performances: EURO3, EURO4, EURO5
  - Different sizes: small (<1,4l), medium (1,4 to 2l), large (>2l)
  - Different fuels: diesel, petrol, LPG, Natural Gas + electric cars
- System boundaries including
  - Car production and maintenance but **no recycling**
  - Fuel or electricity production
  - Use phase (exhaust gas emissions)
  - Li-ion battery (if any but **no recycling**)
  - Infrastructure (road)
  - Brake wear emissions
  - Road wear emissions
  - Tyre wear emissions

Functional unit: 100 km
ILCD 2011 Midpoint+ V1.10 / EC-JRC Global, equal weighting
Ecoinvent in SIMAPRO

Ecoinvent 3: distribution of impact vs steps



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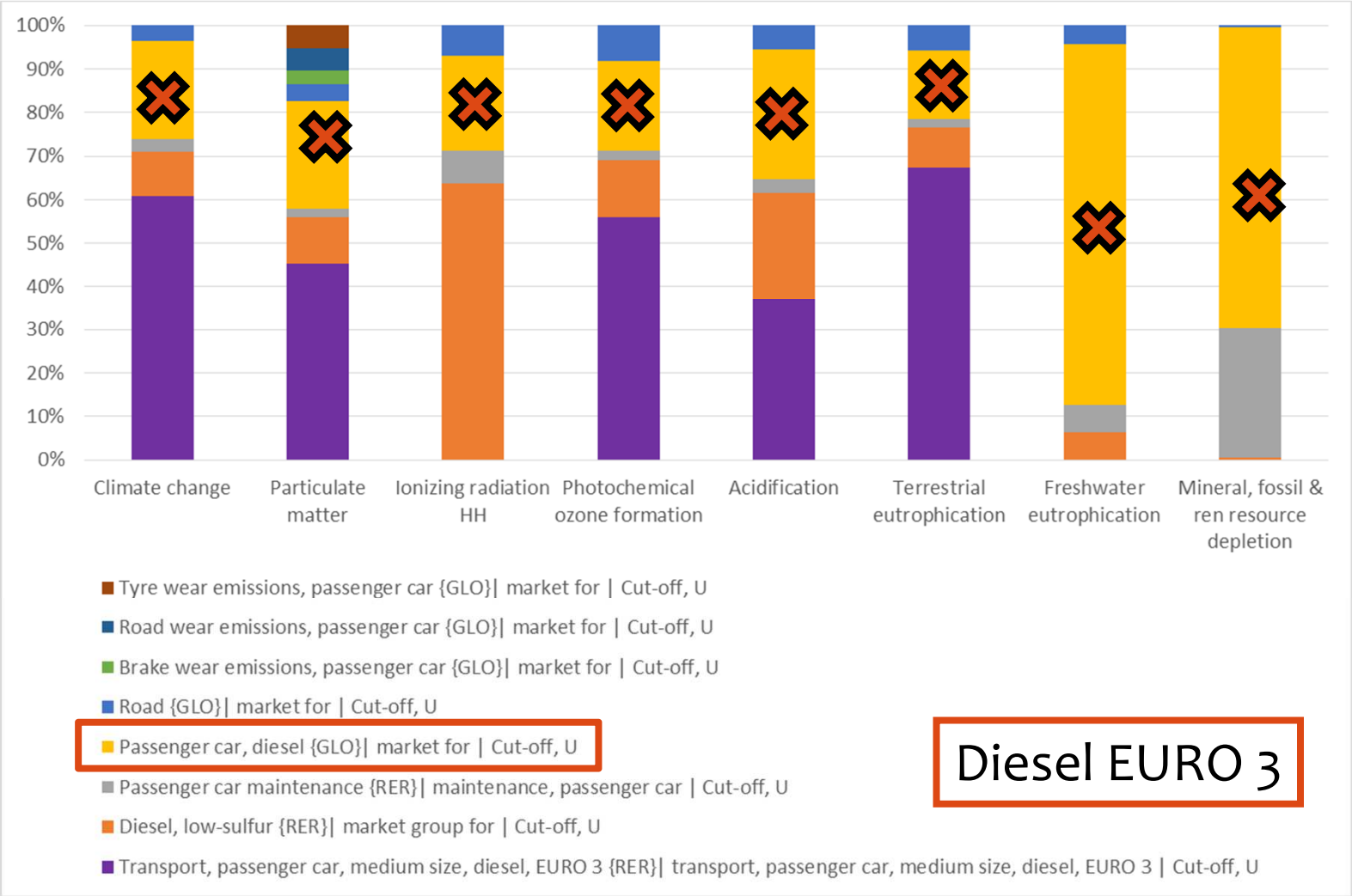

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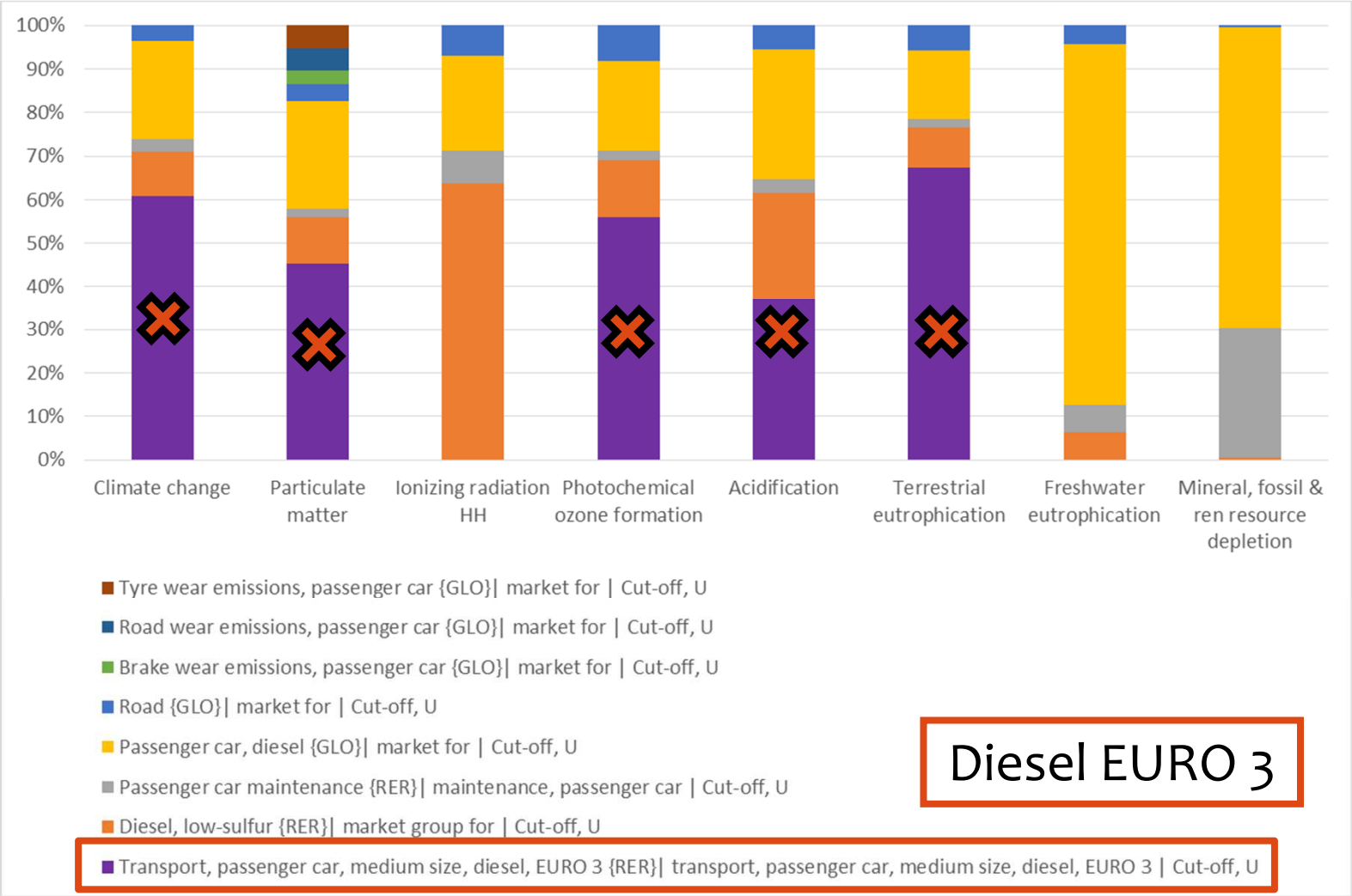

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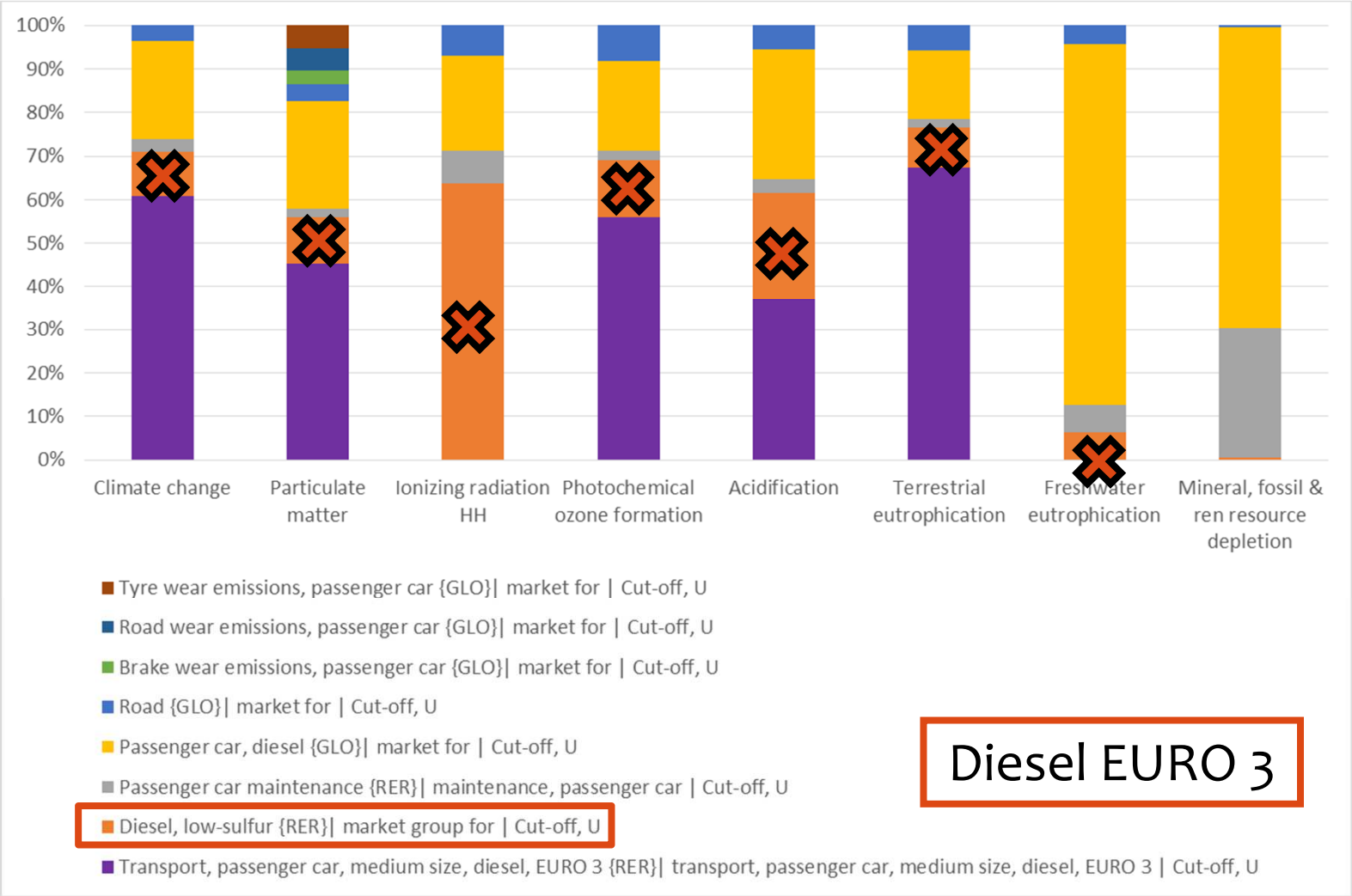

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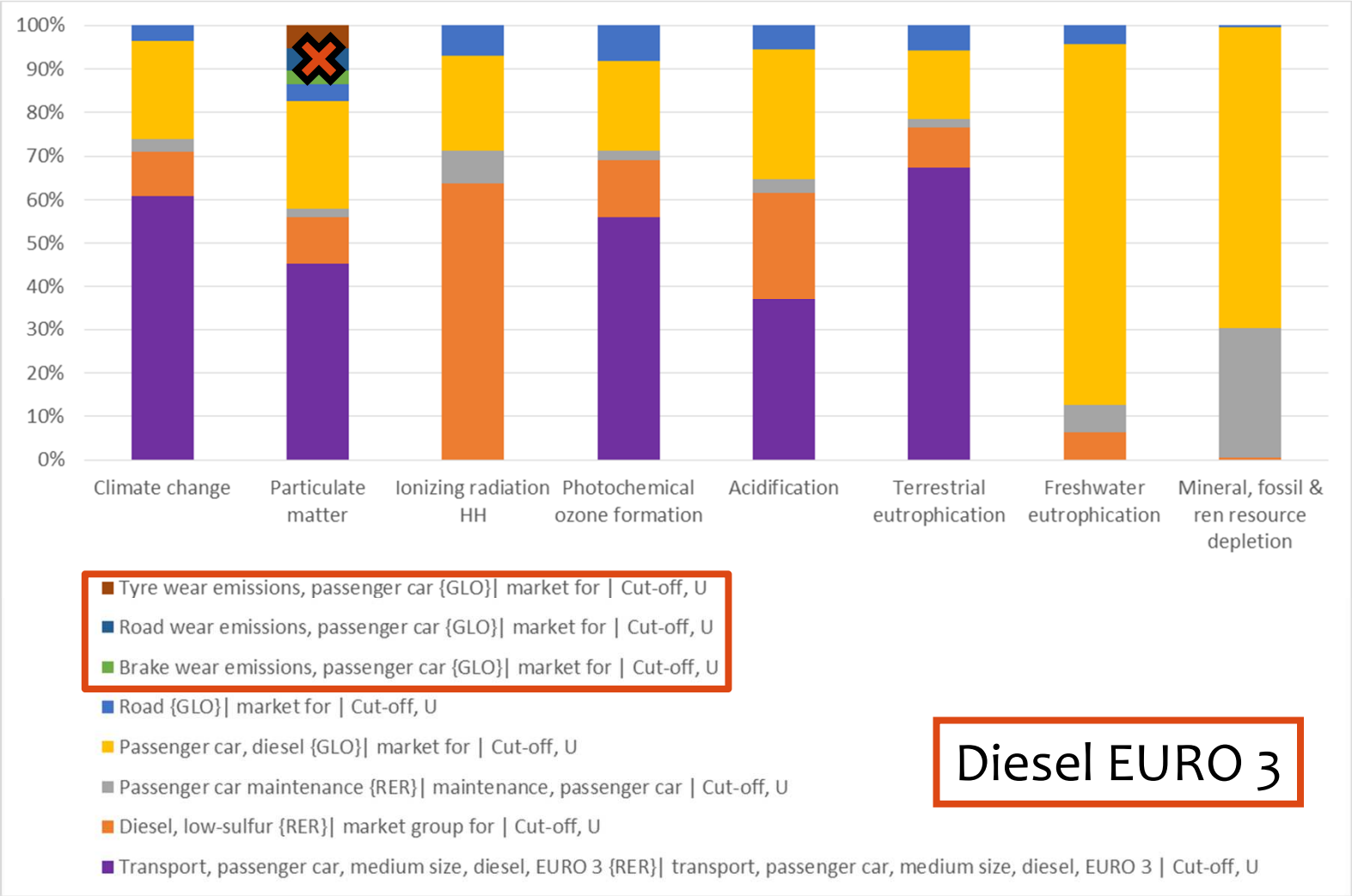
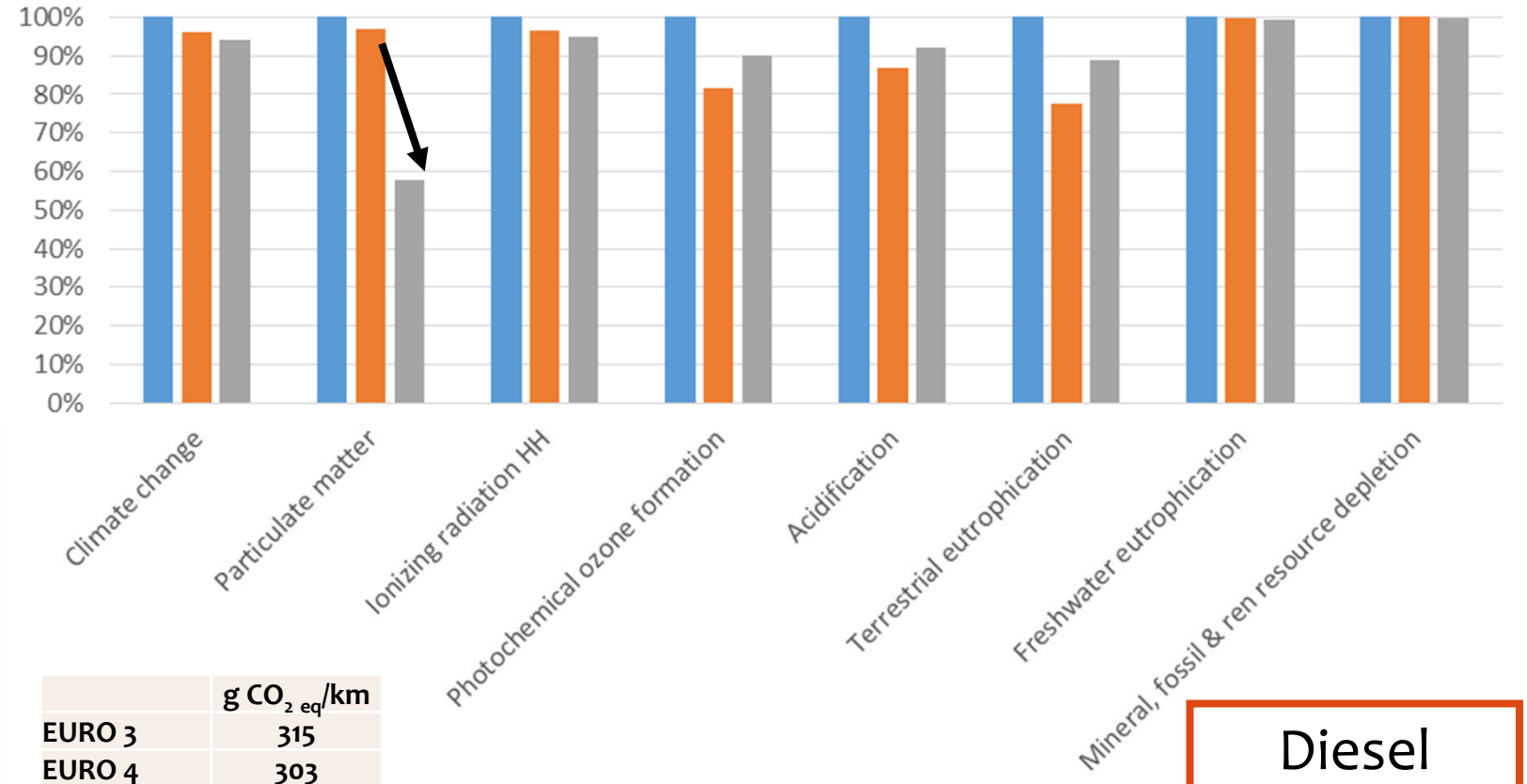


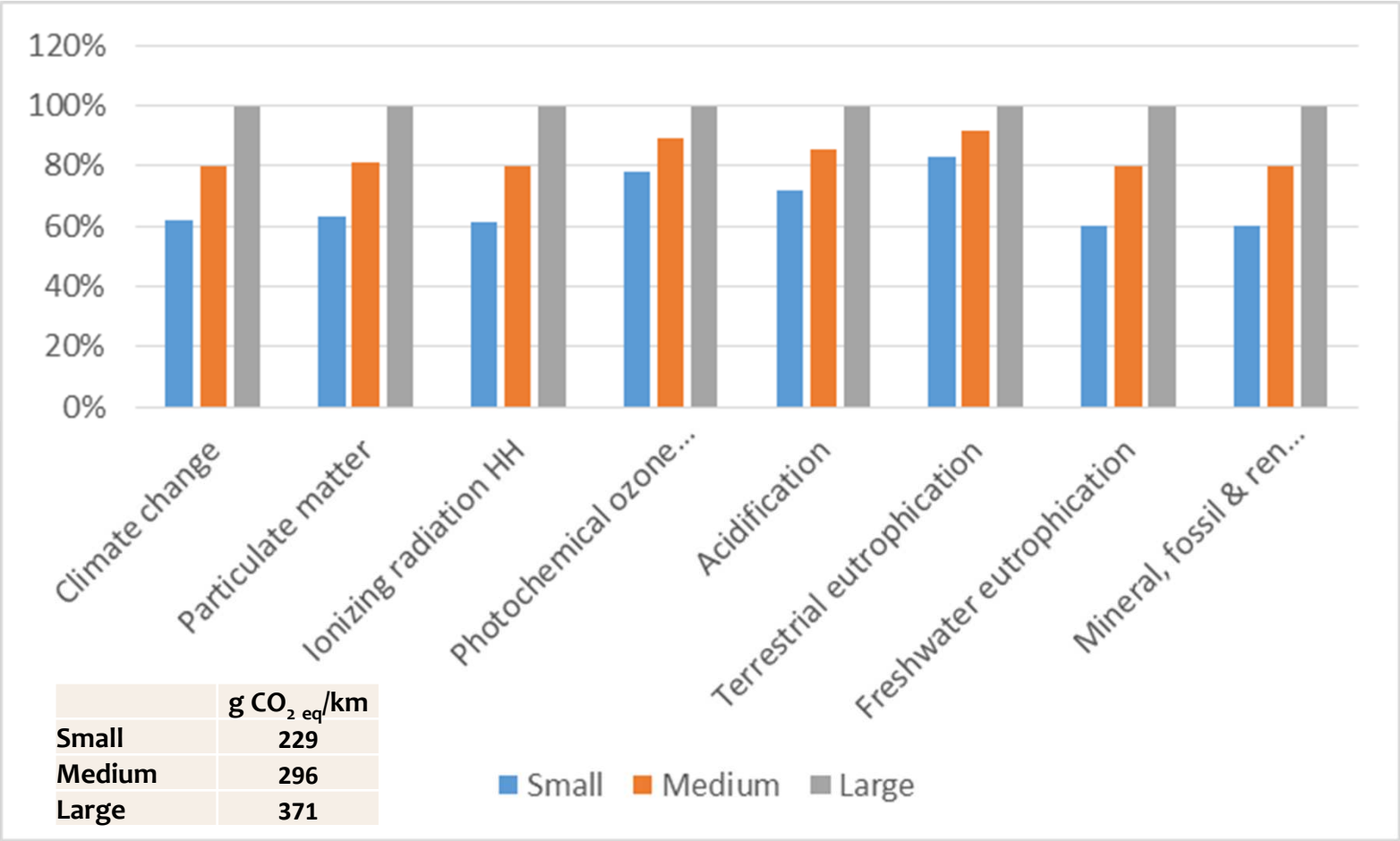
Ecoinvent 3: EURO3 to EURO5, medium size



	g $CO_{2\ eq}$/km
EURO 3	315
EURO 4	303
EURO 5	296

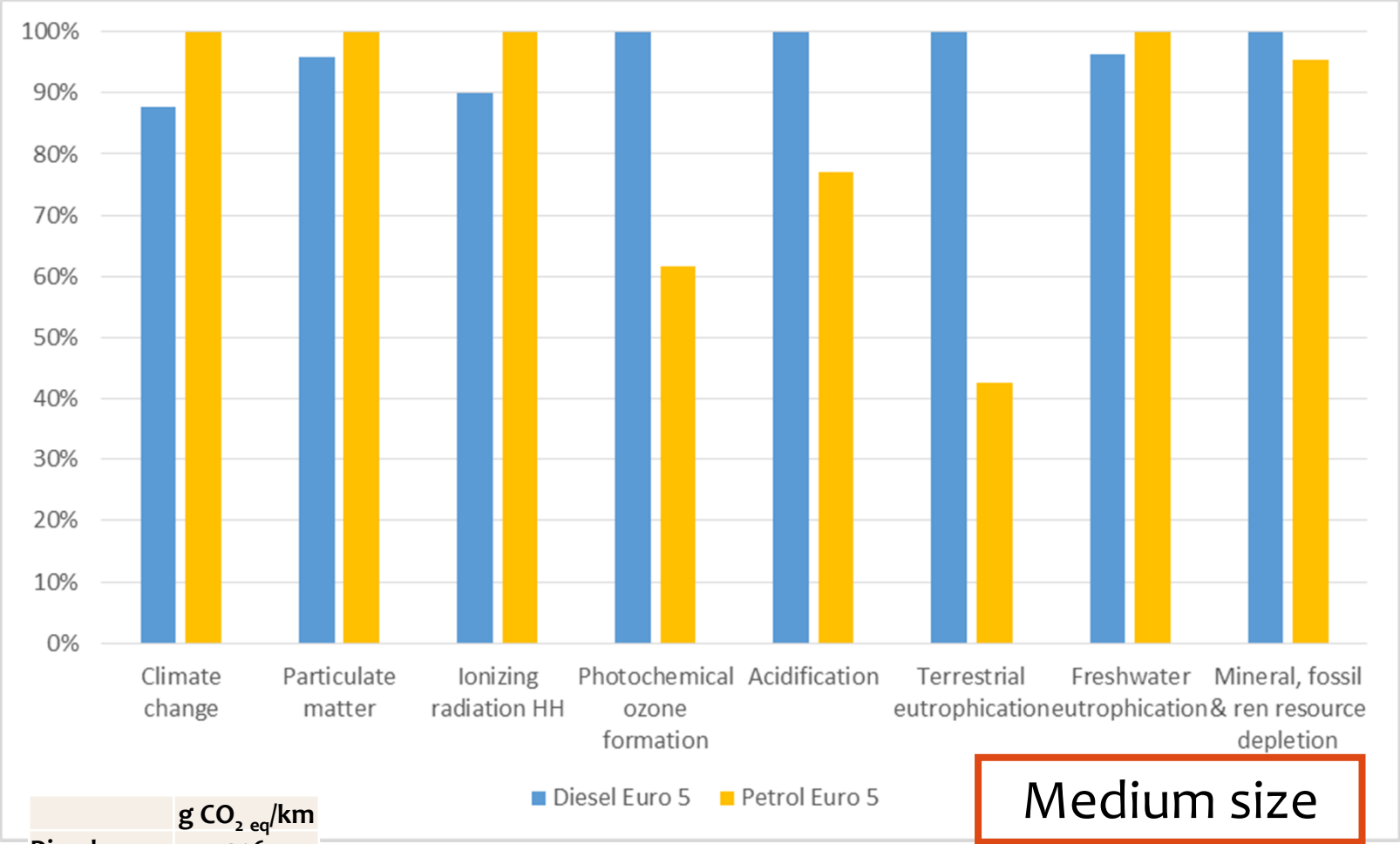
Diesel

Ecoinvent 3: vehicle size, diesel EURO5



	g $CO_{2\ eq}$/km
Small	229
Medium	296
Large	371

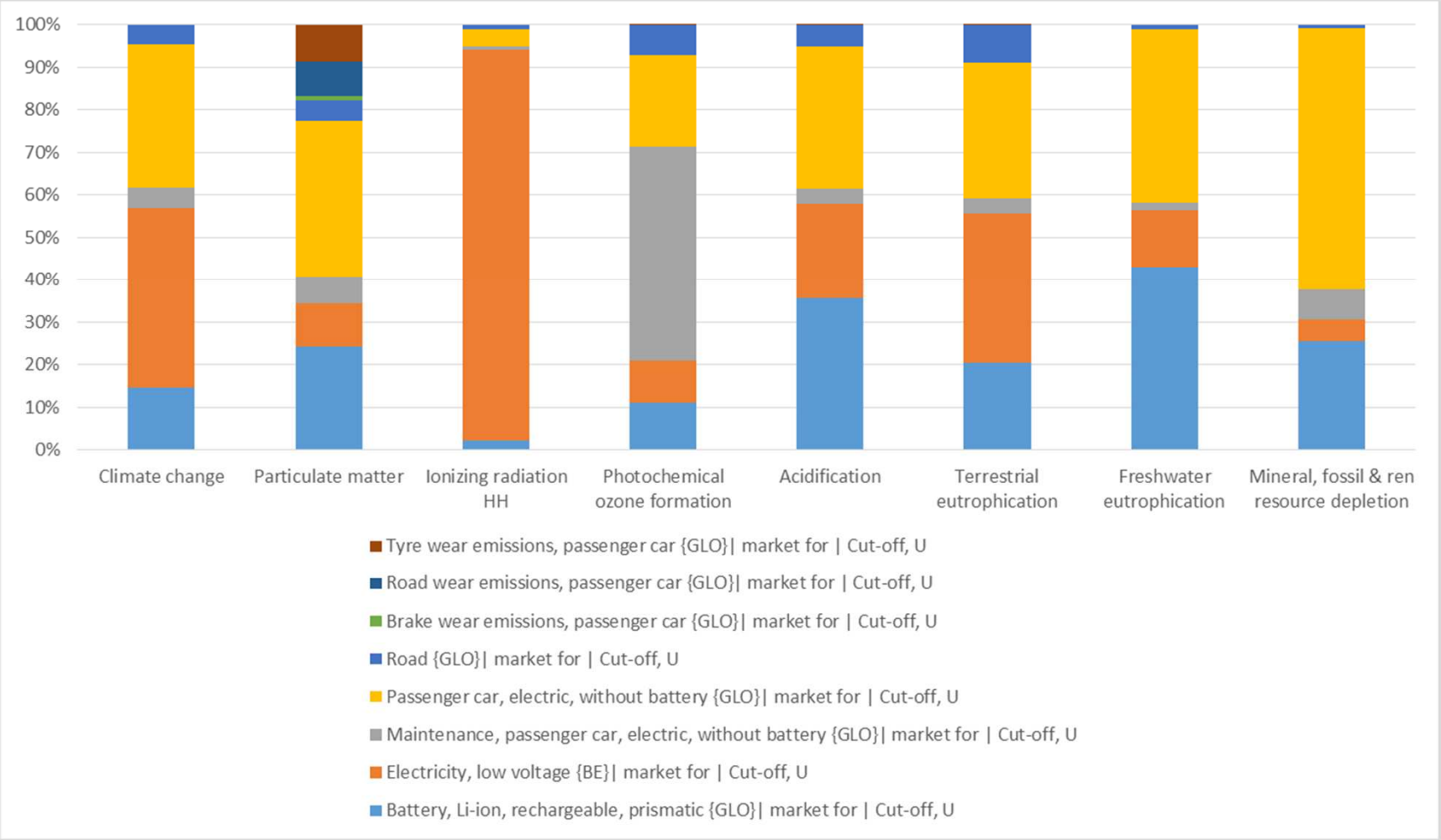
Ecoinvent 3: diesel vs. petrol, Euro 5



Medium size

	g $CO_{2\ eq}$/km
Diesel	296
Petrol	338

Ecoinvent 3: electric vehicle



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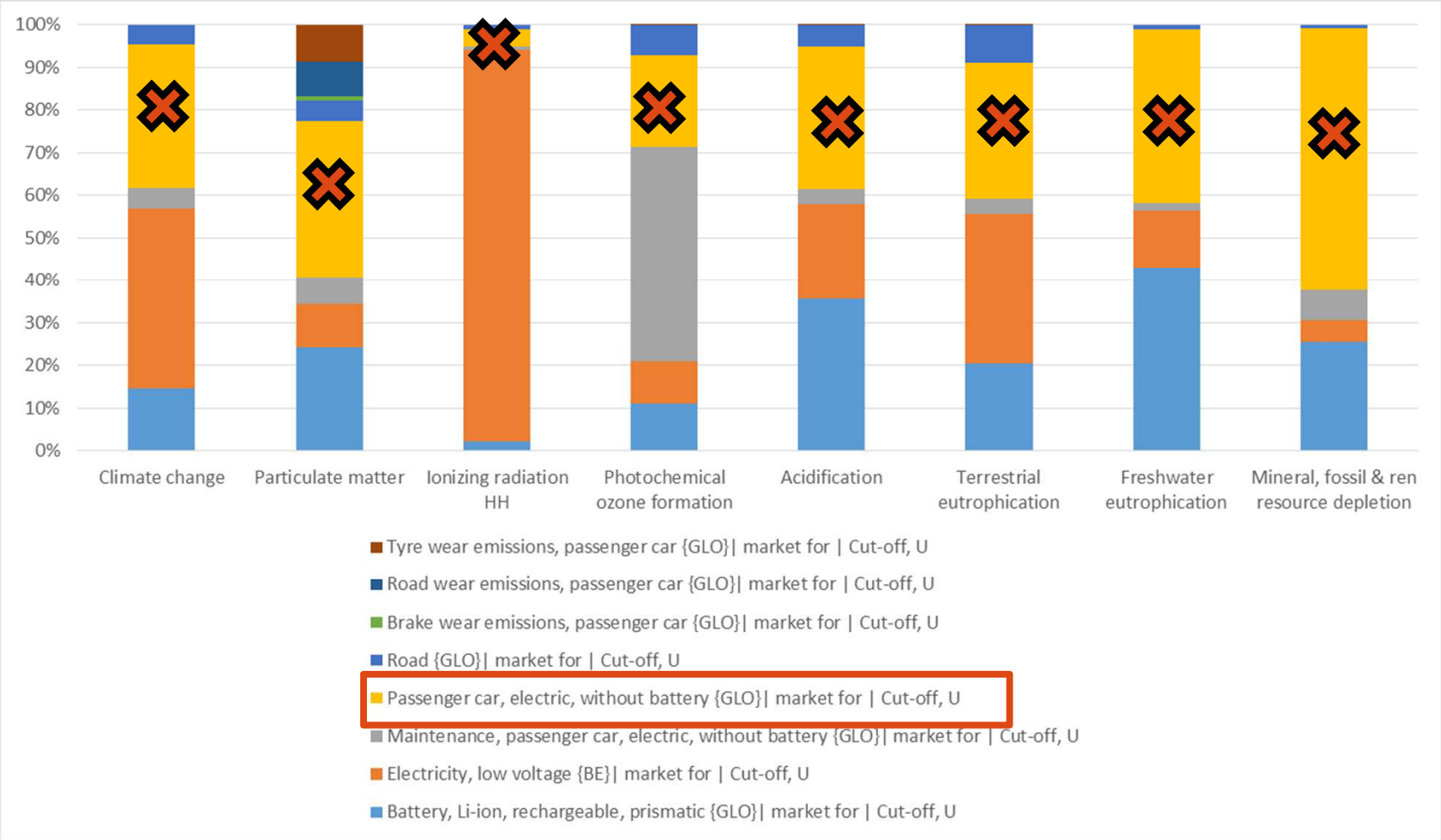

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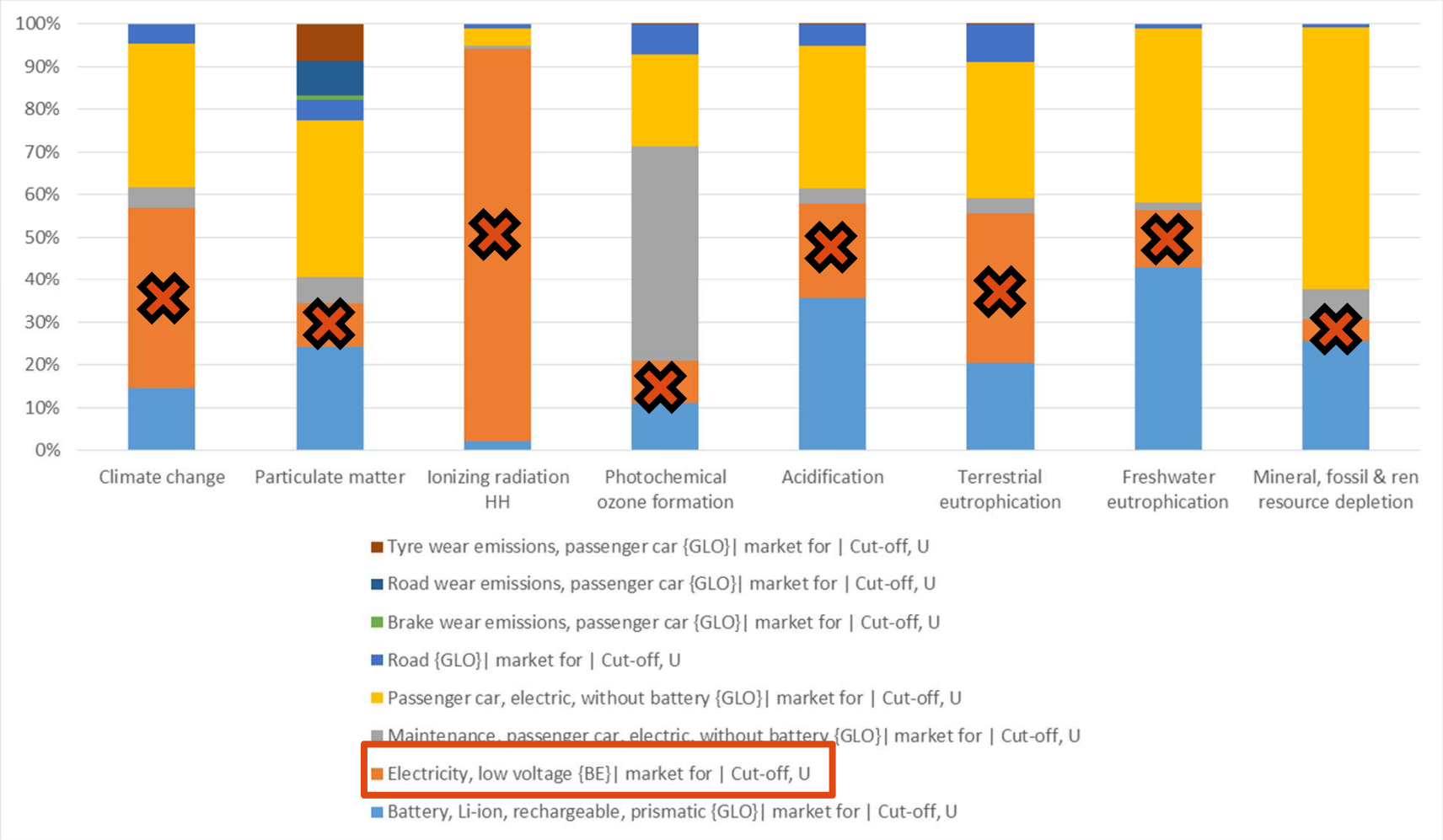

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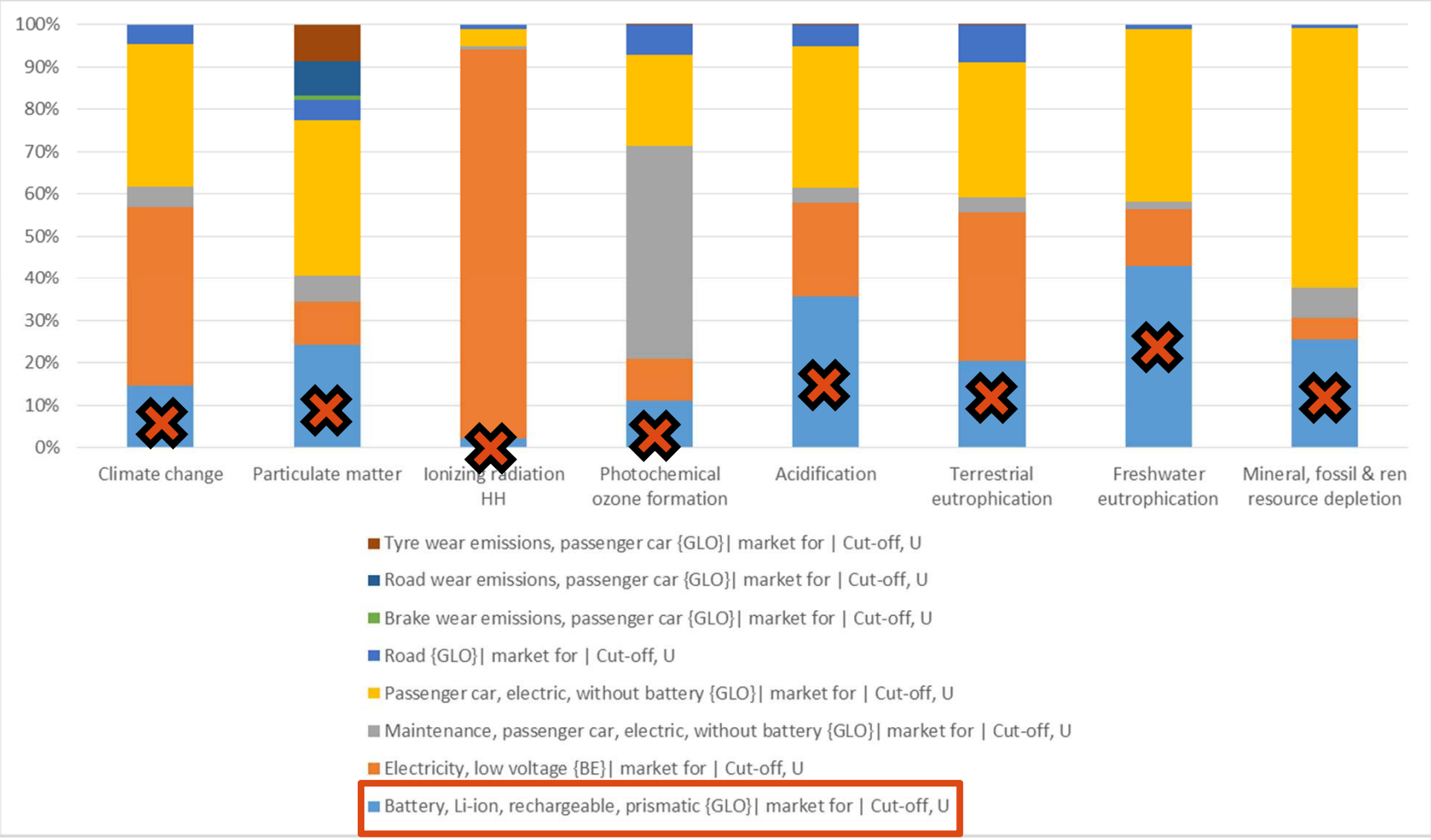
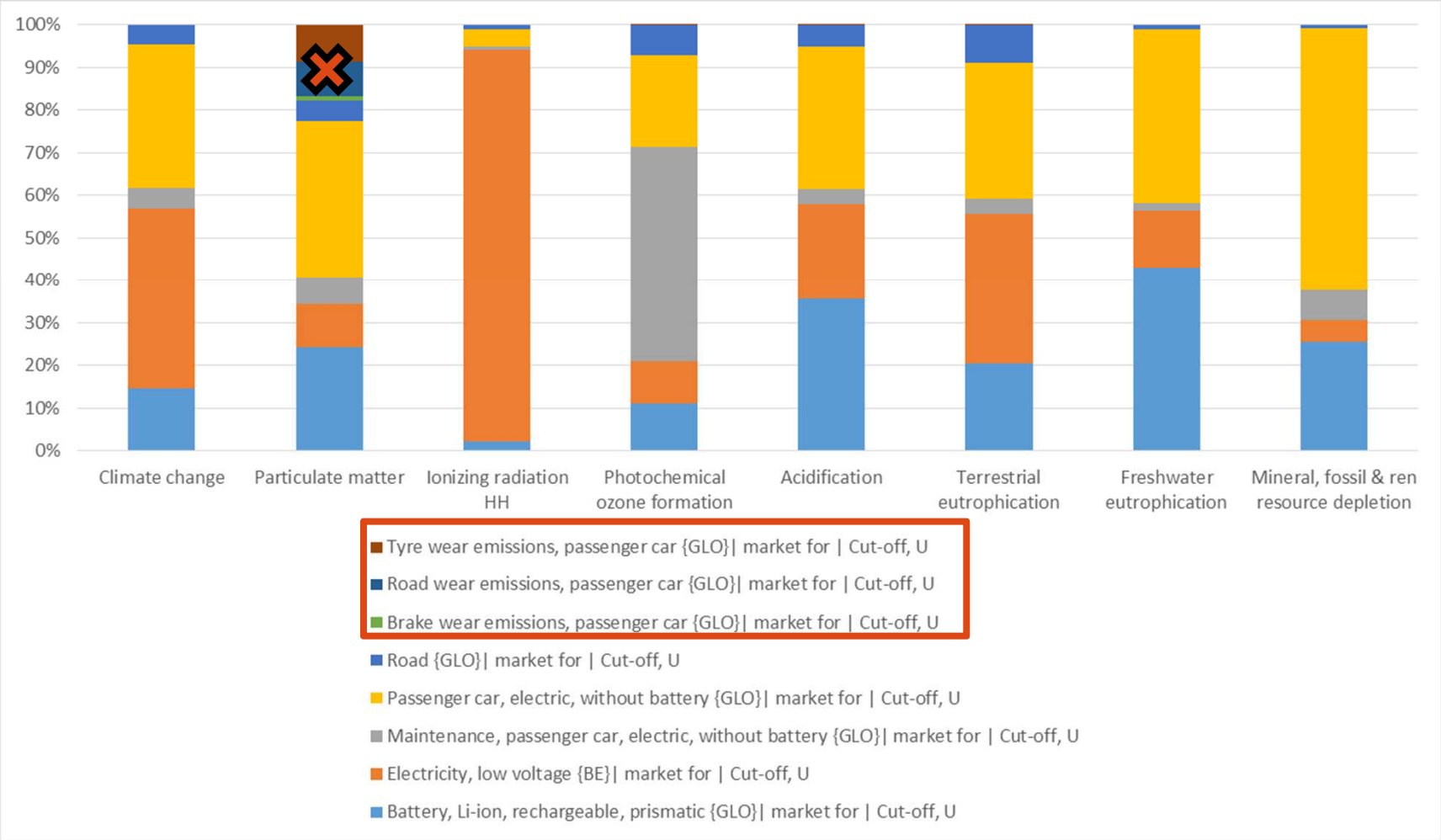
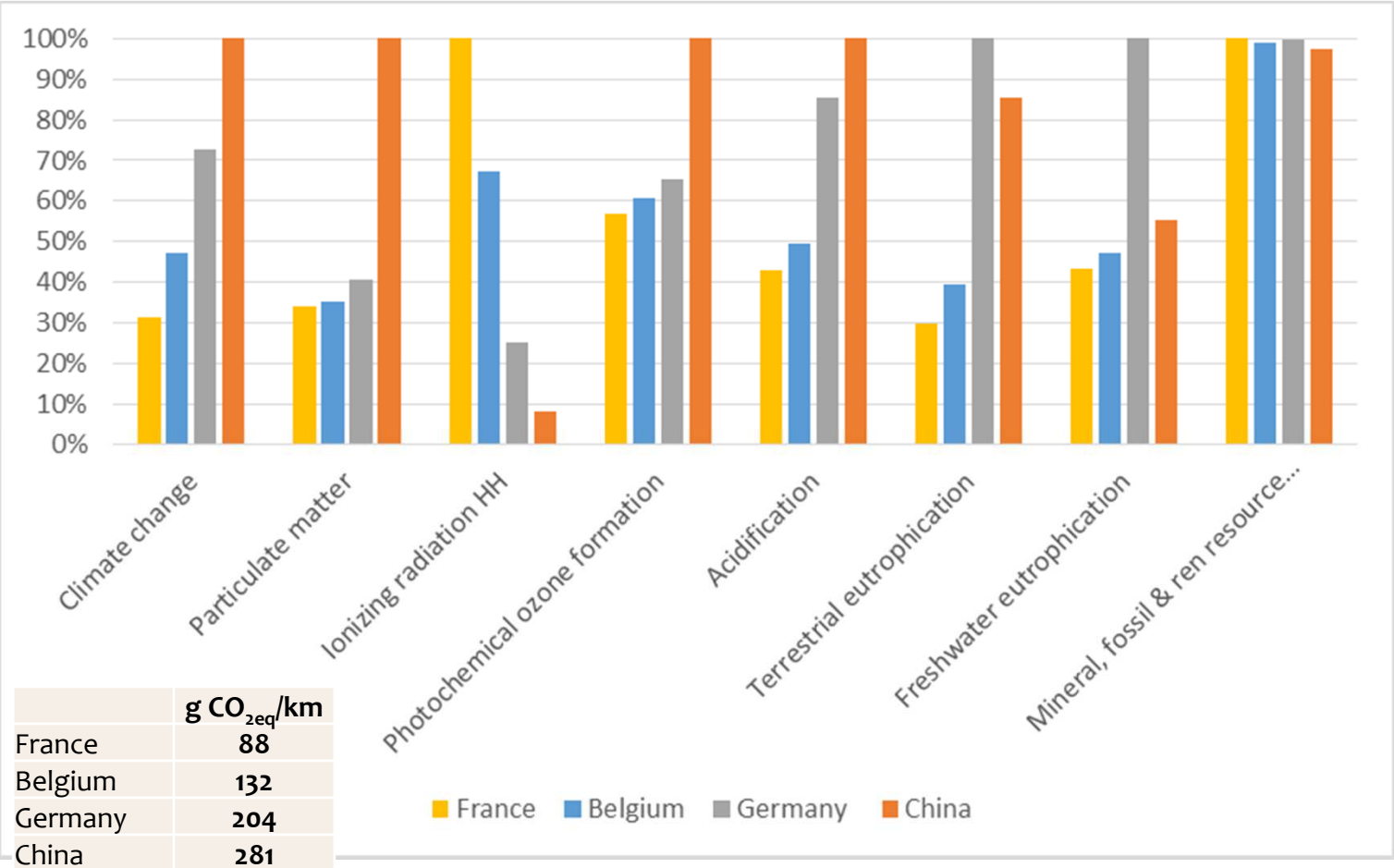


Ecoinvent 3: electric vehicle

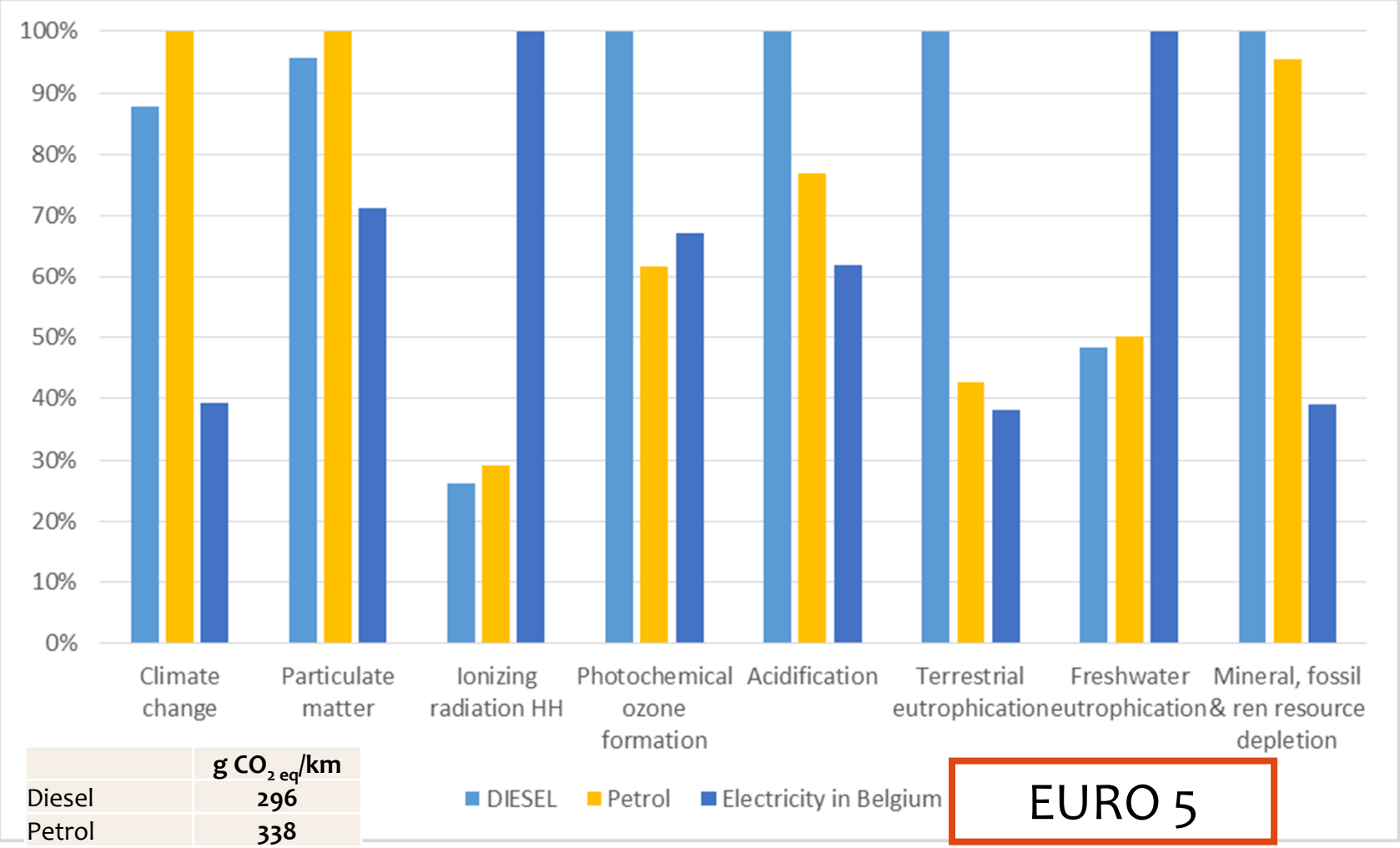


Ecoinvent 3: electric vehicle/electricity mix



	g CO_{2eq}/km
France	88
Belgium	132
Germany	204
China	281

Ecoinvent 3: fossil vs. electric



	g $CO_{2\ eq}$/km
Diesel	296
Petrol	338
Electricity	132

EURO 5

Gabi

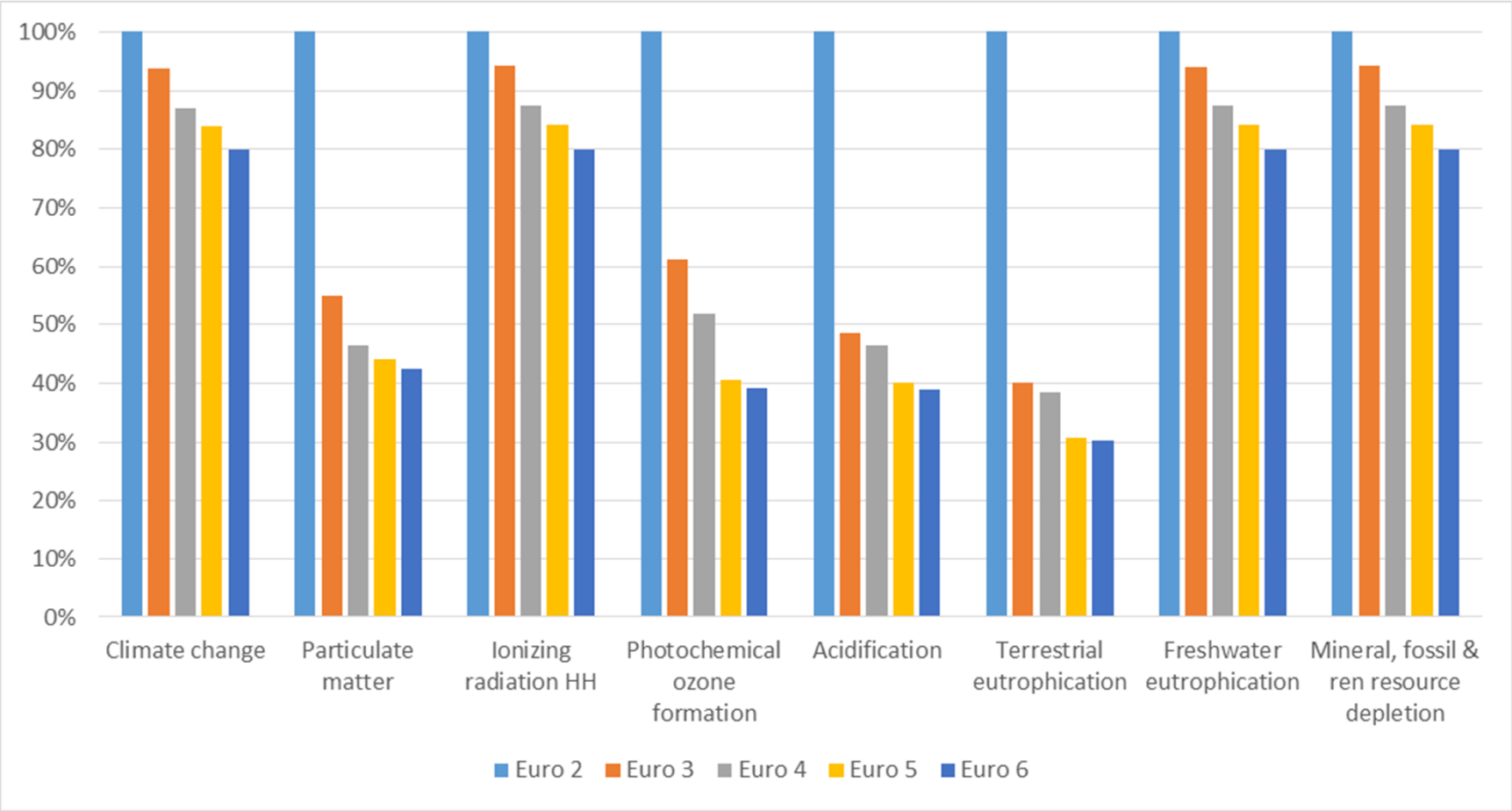
- Passenger cars with
  - Increasing environmental performances: EURO1 to EURO6 (and before)
  - Different sizes: <1,4l, between 1,4 and 2l and > 2l
  - Different fuels: diesel, petrol, LPG, Natural Gas + electric cars (not free)
- System boundaries including only emissions from the combustion of fuel

Gabi

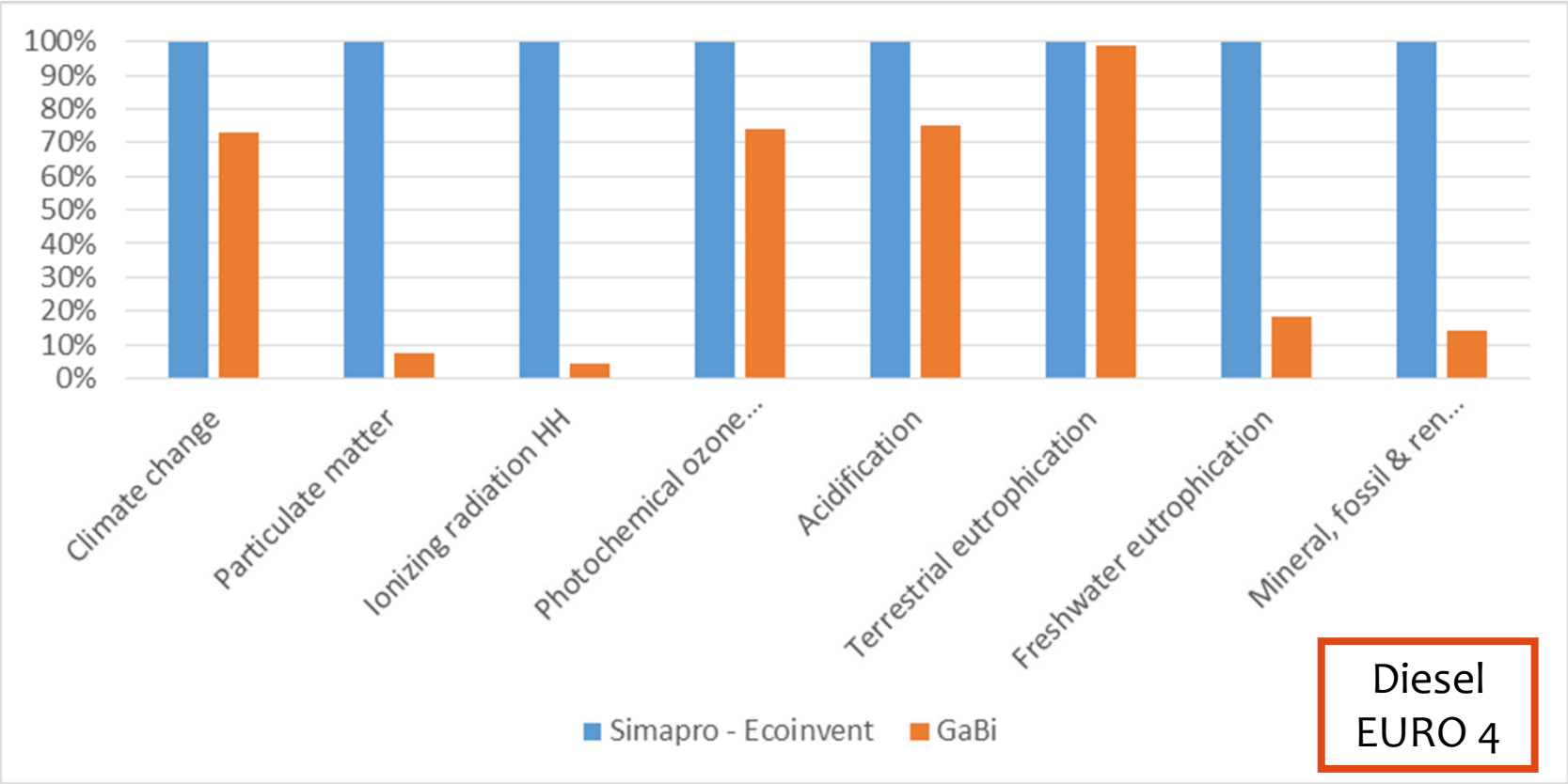
- Not included
  - Vehicle production, repair, maintenance (integration optional where required)
  - Vehicle recycling (integration optional where required)
  - Infrastructure (roads etc.)
  - Noise
  - Diurnal losses and refuelling losses (see [6])
  - Hot-Soak-Emissions
  - Oil use
  - Cold-Start Emissions
  - Emissions from air conditioning (relevance < 1 %, see [4])
  - Abrasion of tyres and brakes
  - Production and emissions of glycol and detergent from window washing systems

Functional unit: 100 km
ILCD 2011 Midpoint+ V1.10 / EC-JRC Global, equal weighting
GaBi

Gabi – Petrol from Euro 2 to Euro 6



Gabi vs. Ecoinvent/same boundaries !!



Diesel
EURO 4

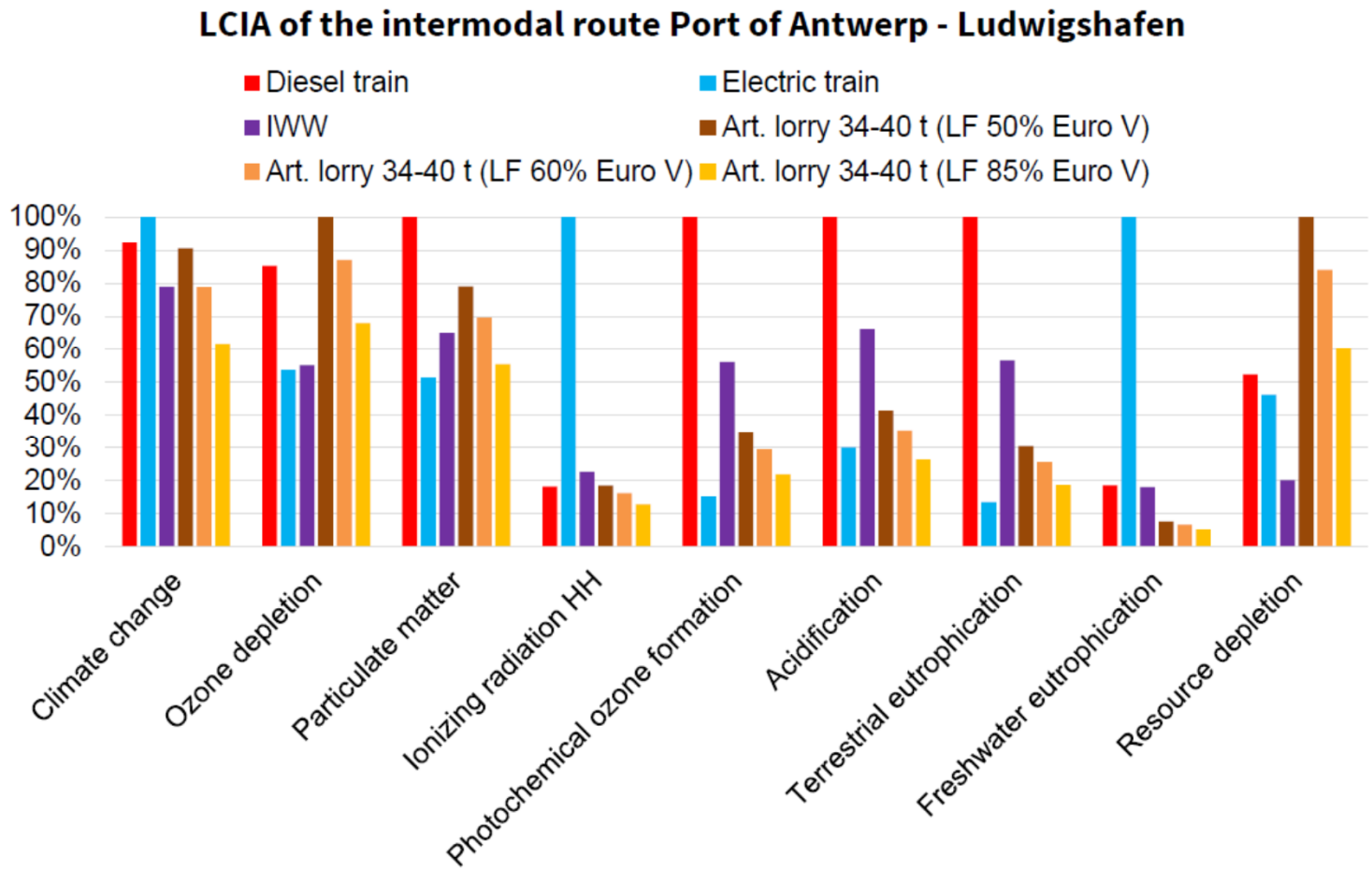
Conclusions

Take-home message

- LCA = useful but complex methodology
  - LCA softwares must not be used blindly by non experts
  - Be careful to system boundaries
  - Be careful to data: generic vs. specific
- Reliable LCA must rely on specific data coming from all the stakeholders or players in automotive fields
  - Recycling step of the vehicles
  - Battery
  - Exhaust emissions in the real life
  - …
- Needs of transparency and access to data

Last example …

- Attractive solutions are not always the right ones !!



Questions ?