



Swiss Centre for Life Cycle Inventories

A joint initiative of the
ETH domain and Swiss
Federal Offices

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InLCA/LCM international conference
October 4-6, 2006, Washington DC

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The environmental relevance of capital goods in life cycle assessments of products and services

The logo for ETH (Eidgenössische Technische Hochschule), consisting of the letters 'ETH' in a bold, italicized, black sans-serif font.

The logo for EPFL (École Polytechnique Fédérale de Lausanne), consisting of the letters 'EPFL' in a white sans-serif font inside a red square.

The logo for PSI (Paul Scherrer Institut), consisting of the letters 'PSI' in a white sans-serif font inside a grey square.

The logo for EMPA (Empirech Materials Processing and Applied Chemistry Laboratory), consisting of the letters 'EMPA' in a white sans-serif font inside a red square with a white cross.

The logo for ART (Applied Research Technology), consisting of the letters 'ART' in a white sans-serif font inside a red square with a white cross.

Rolf Frischknecht, Hans-Jörg Althaus, Christian Bauer, Gabor Doka, Thomas Heck, Niels Jungbluth, Daniel Kellenberger, Thomas Nemecek

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Problem setting and thesis



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Inclusion or exclusion of capital goods in LCA is disputed:

- **Capital equipment shall be part of any LCA in any case!**

But, this makes my product system explode!

- **Capital equipment shall be excluded per se!**

But then we risk to miss significant parts of the environmental impacts!

Thesis:

- **Capital equipment must be included in cases where relevant!**

Criteria need to be defined!

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History of capital goods discussion



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- Boustead & Hancock, 1979:
capital goods contribute about 5% to CED
- Heijungs et al., 1992:
“identify capital goods as memory items”
- ISO standards, 1997:
capital equipment explicitly part of product systems
- Databases (examples):
 - consistently excluded: BUWAL 250 (1996)
 - consistently included: ETHZ-ESU (1994/1996)
ecoinvent data v1.2 (2005)

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Definition and operationalisation



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- Capital good:
goods, such as machineries, used in the production of commodities (articles of trade or commerce); producer goods
- Implementation in the ecoinvent database:
Distinction between
 - operation (of a process)
 - capital good manufacture (used in that process)
- EcoSpold data format:
Data field #493 (InfrastructureProcess)

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Computation of capital goods' contribution



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$$CG_i = \frac{LCIA_i^{incl} - LCIA_i^{excl}}{LCIA_i^{incl}}$$

CG_i : Capital goods' contribution to life cycle impact ' i '

$LCIA_i^{incl}$: cumulative impact assessment result,
impact ' i ', **including** capital goods

$LCIA_i^{excl}$: cumulative impact assessment result,
impact ' i ', **excluding** capital goods

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LCIA methods applied

- Proxy indicators:
Cumulative energy demand, fossil & nuclear
- Midpoint methods (based on CML 2001 and IPCC 2001):
 - acidification potential
 - eutrophication potential
 - freshwater aquatic ecotoxicity
 - human toxicity
 - ionising radiation
 - land use (competition)
 - terrestrial ecotoxicity
 - climate change (100a)
- End point indicators (eco-indicator 99 (H,A):
mineral resources, ecosystem health, human health, total



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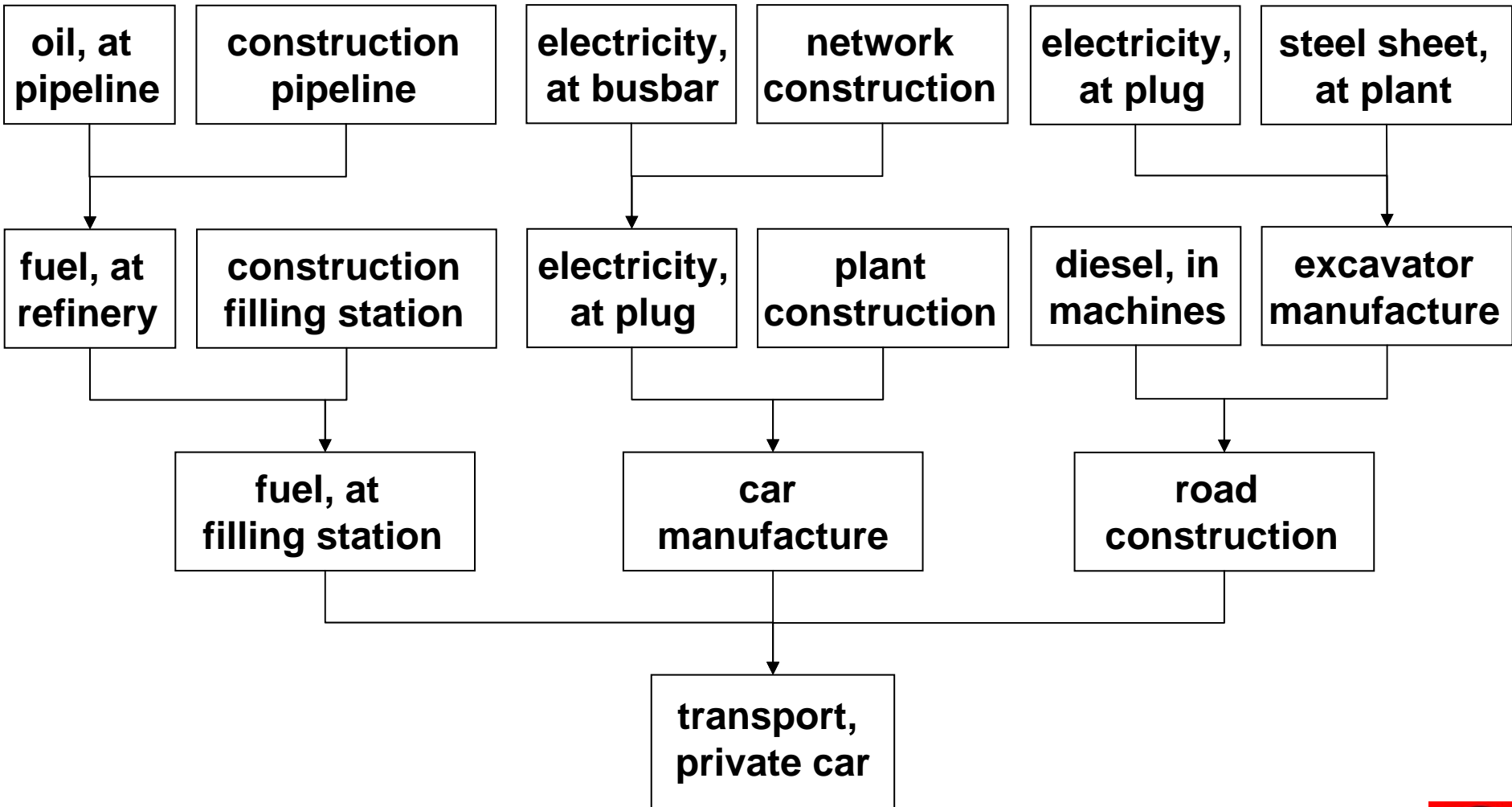
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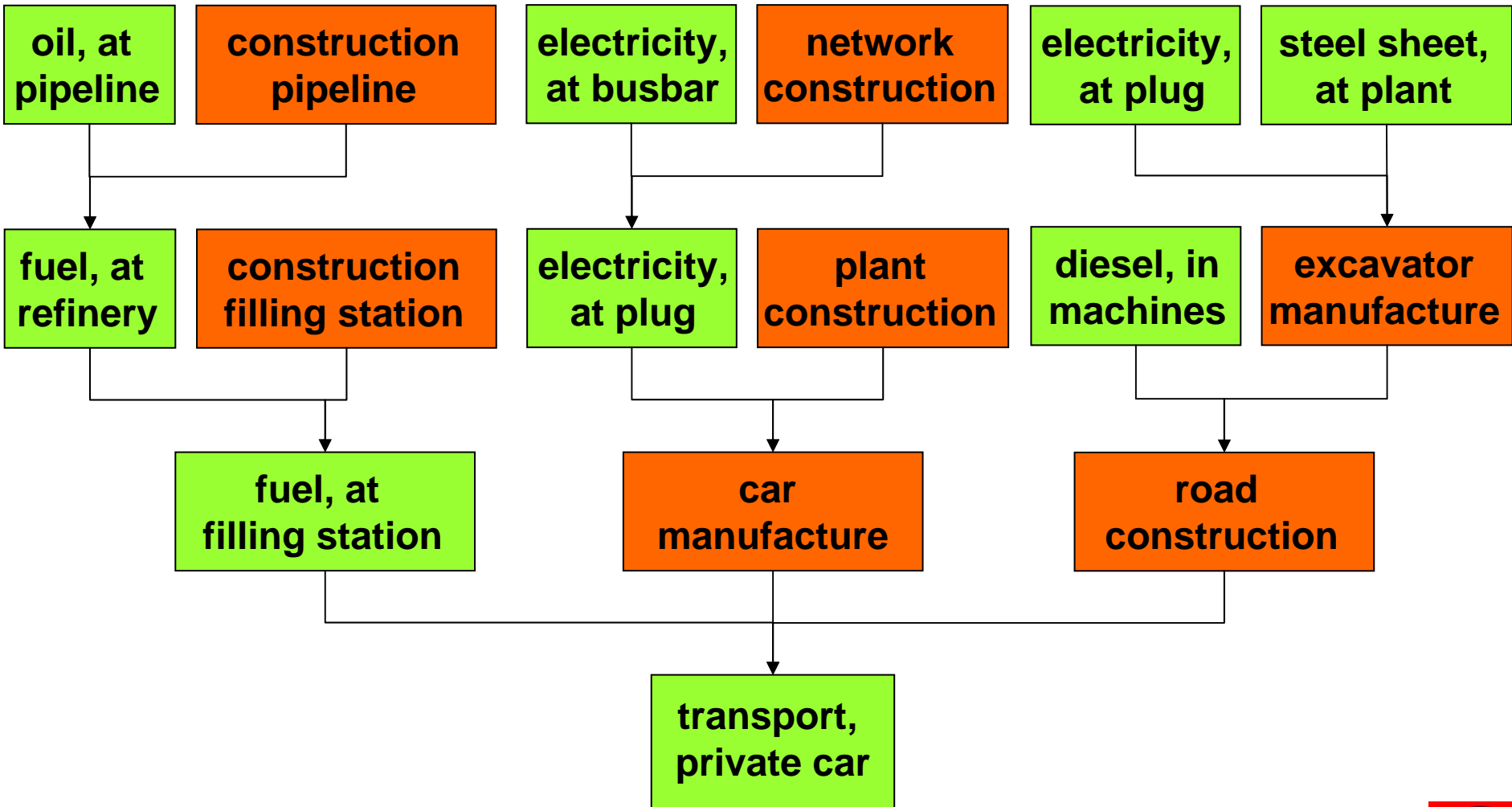
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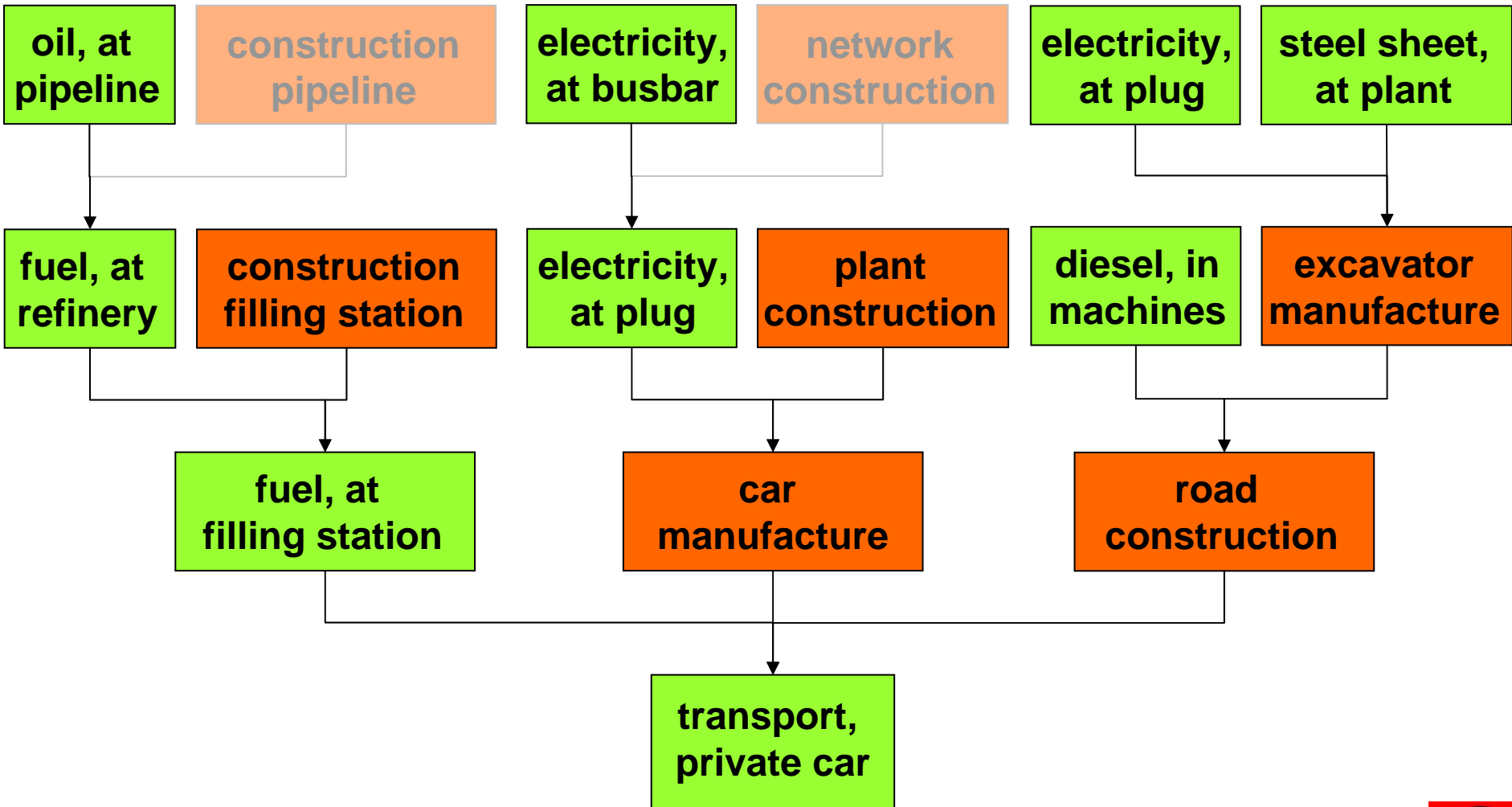
Example: private car transport



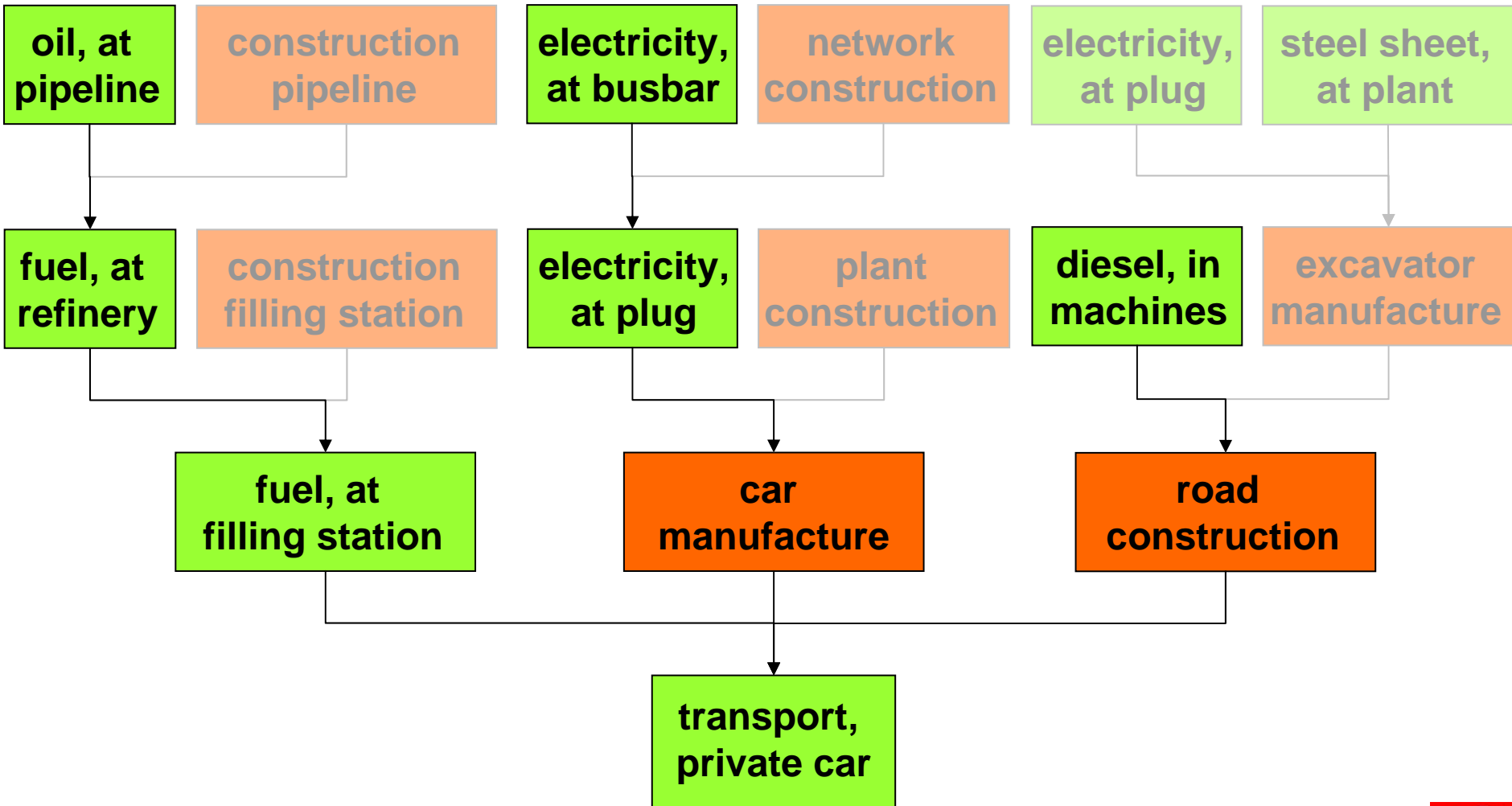
Operation versus capital goods



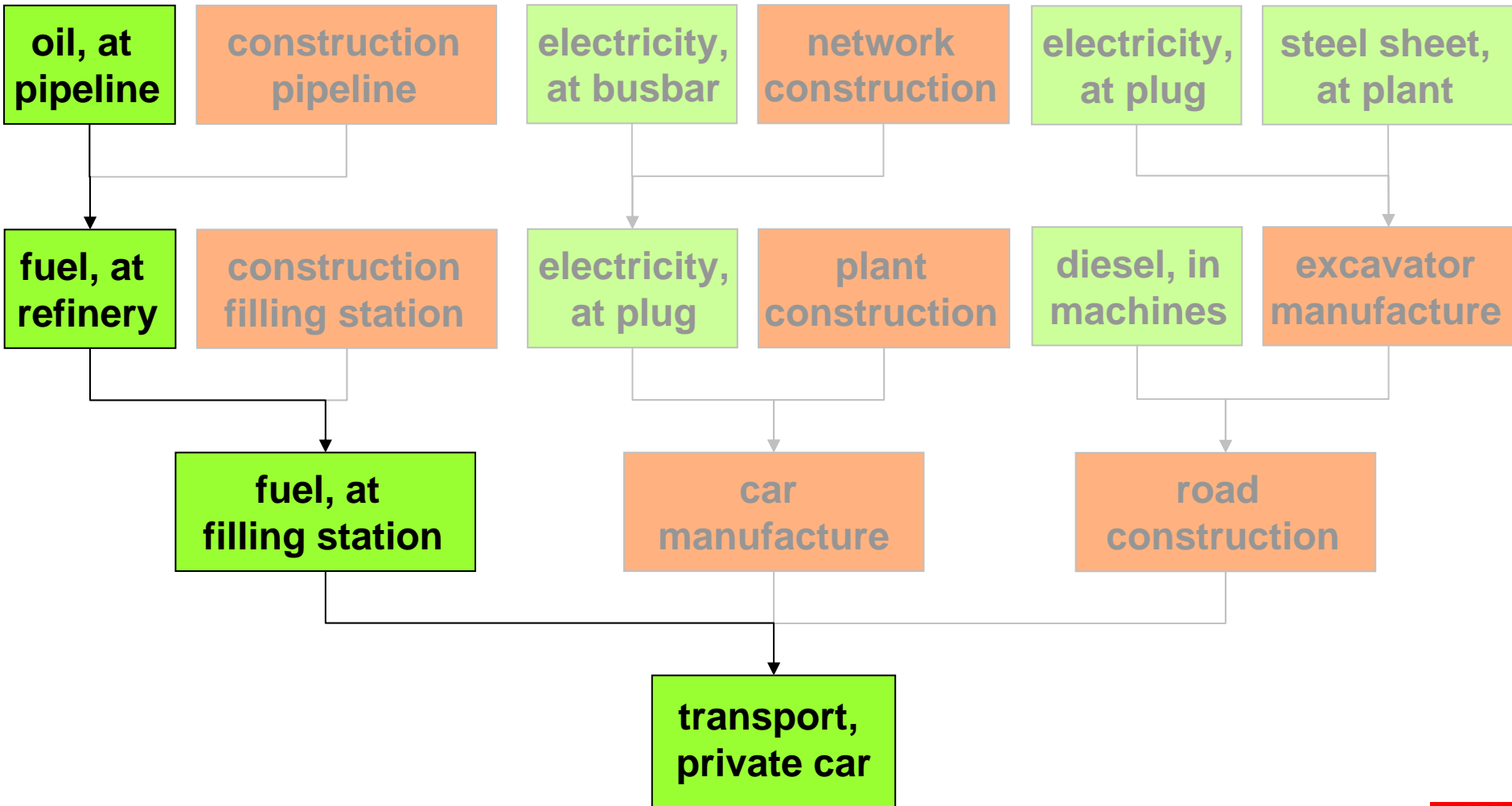
Exclusion of capital goods manufacture



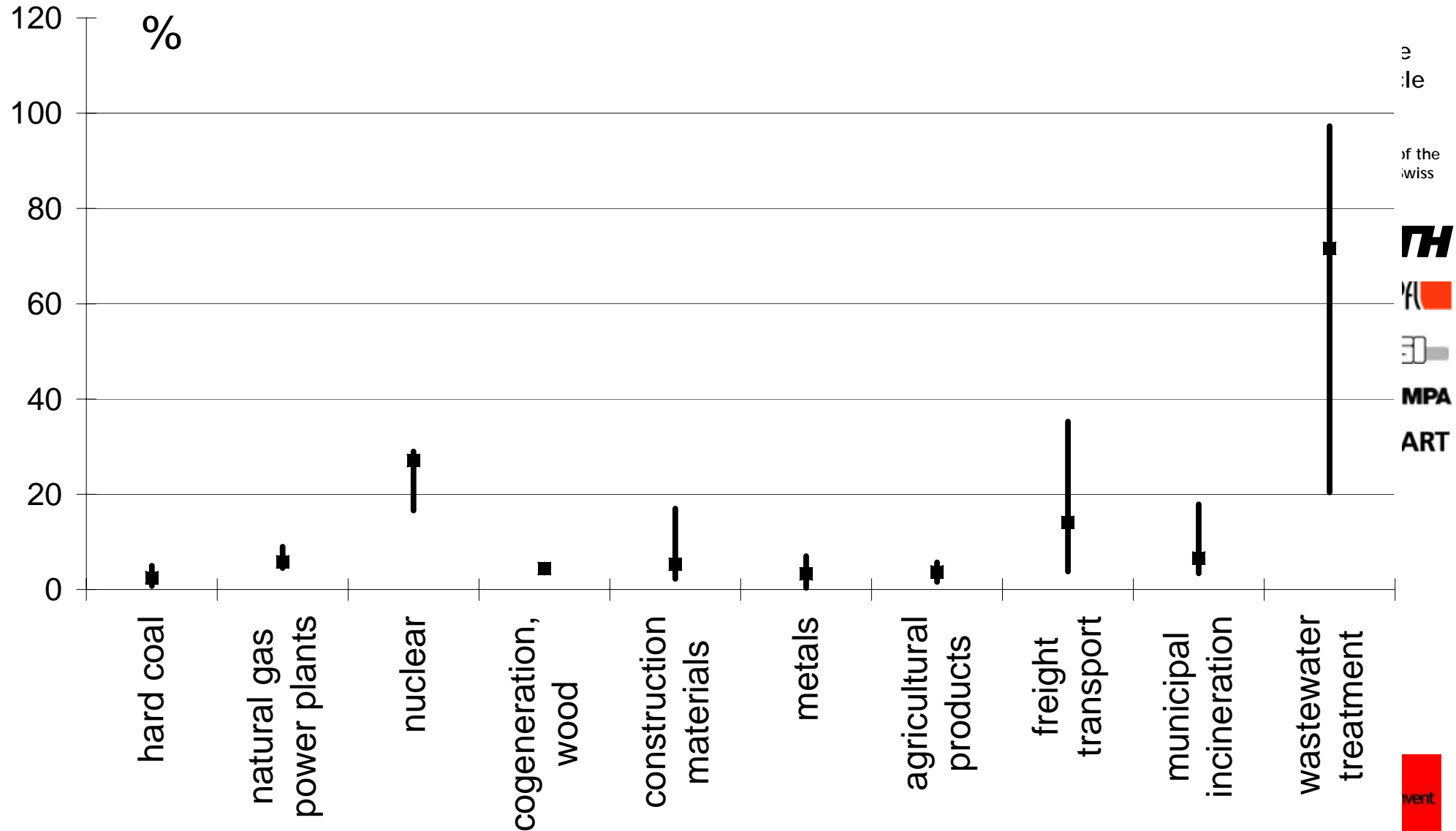
Exclusion of capital goods manufacture, cont.



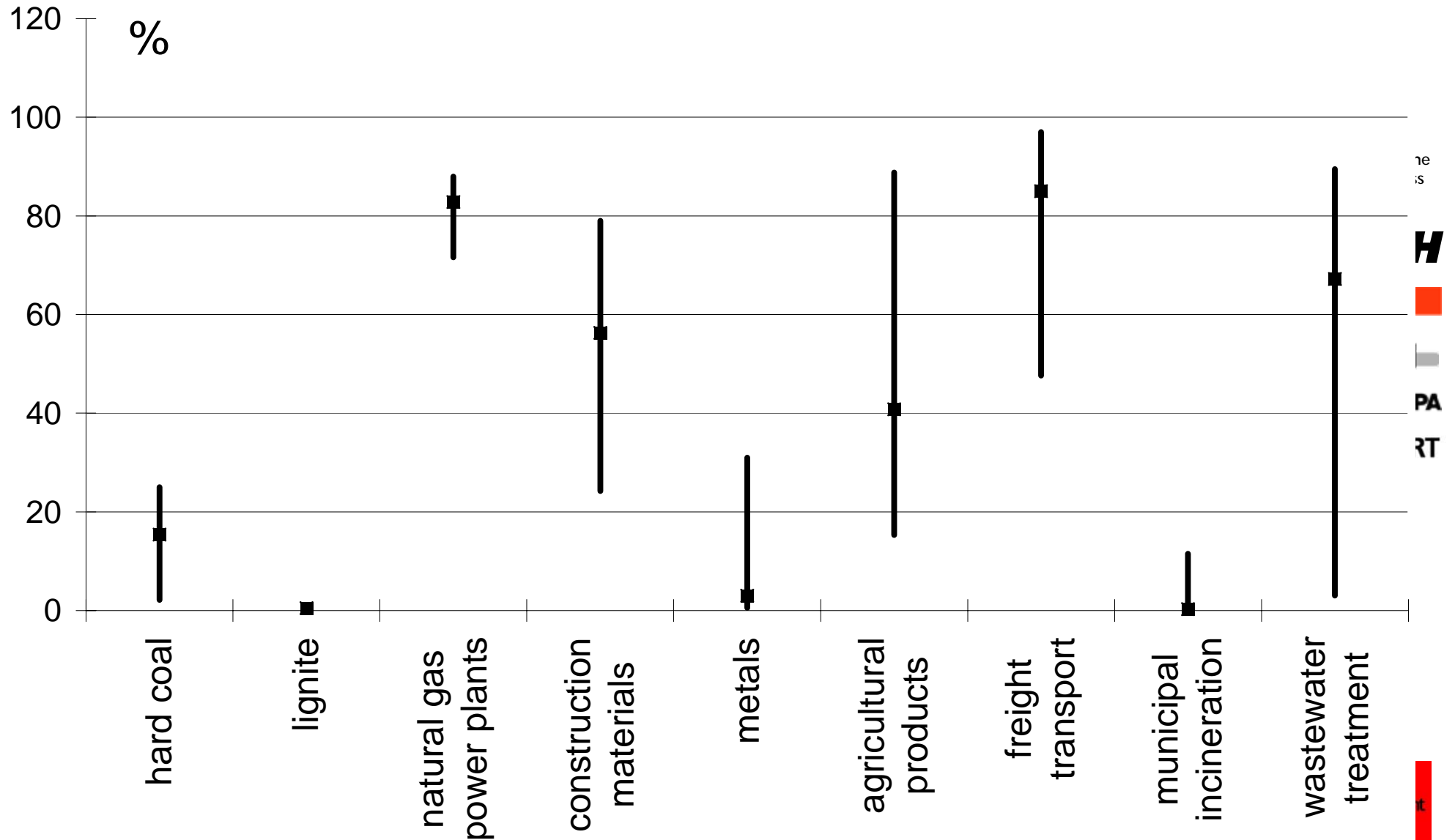
Exclusion of capital goods manufacture, cont.



Share of capital goods on total impacts: Acidification



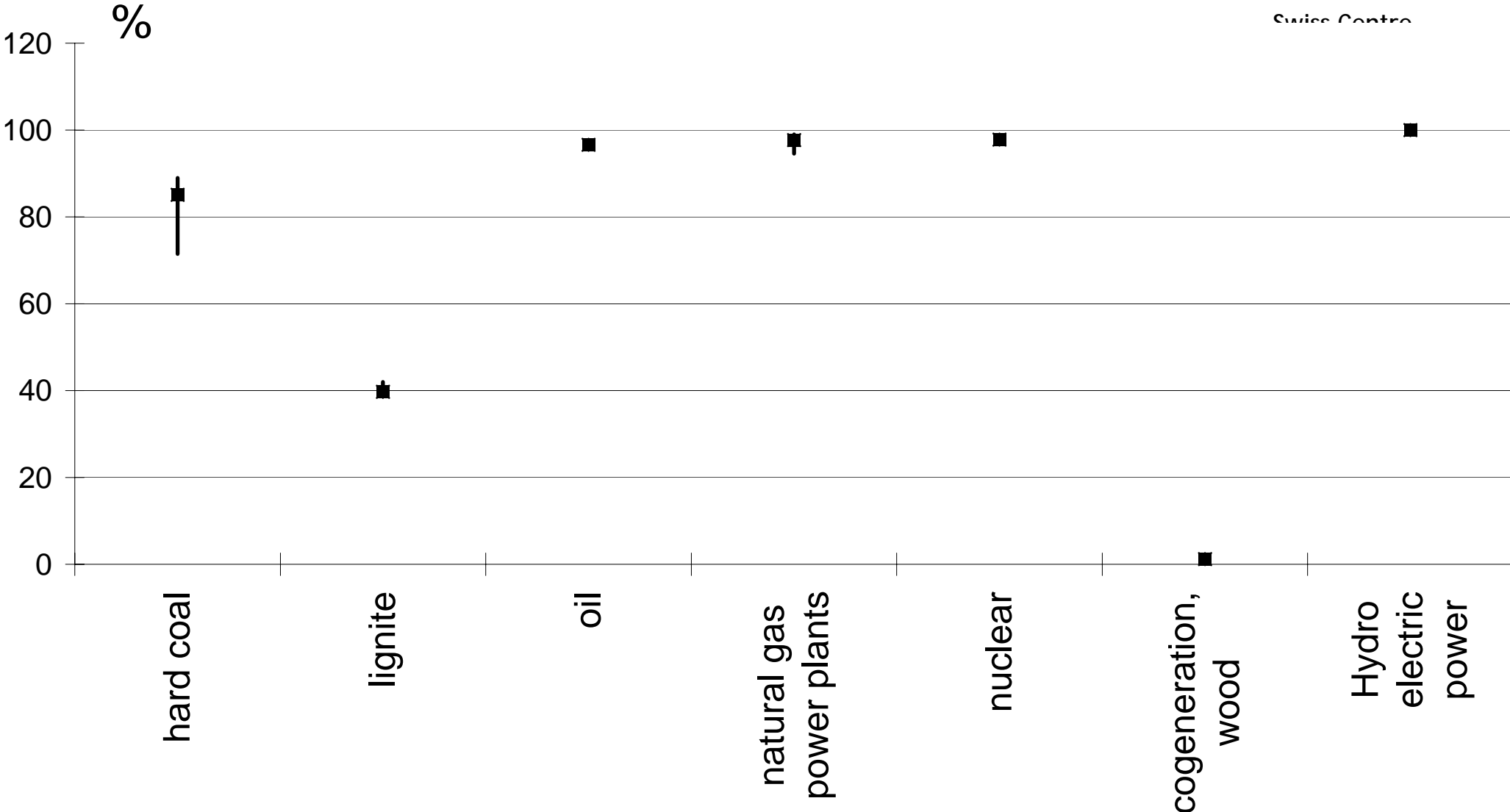
Share of capital goods on total impacts: freshwater ecotoxicity



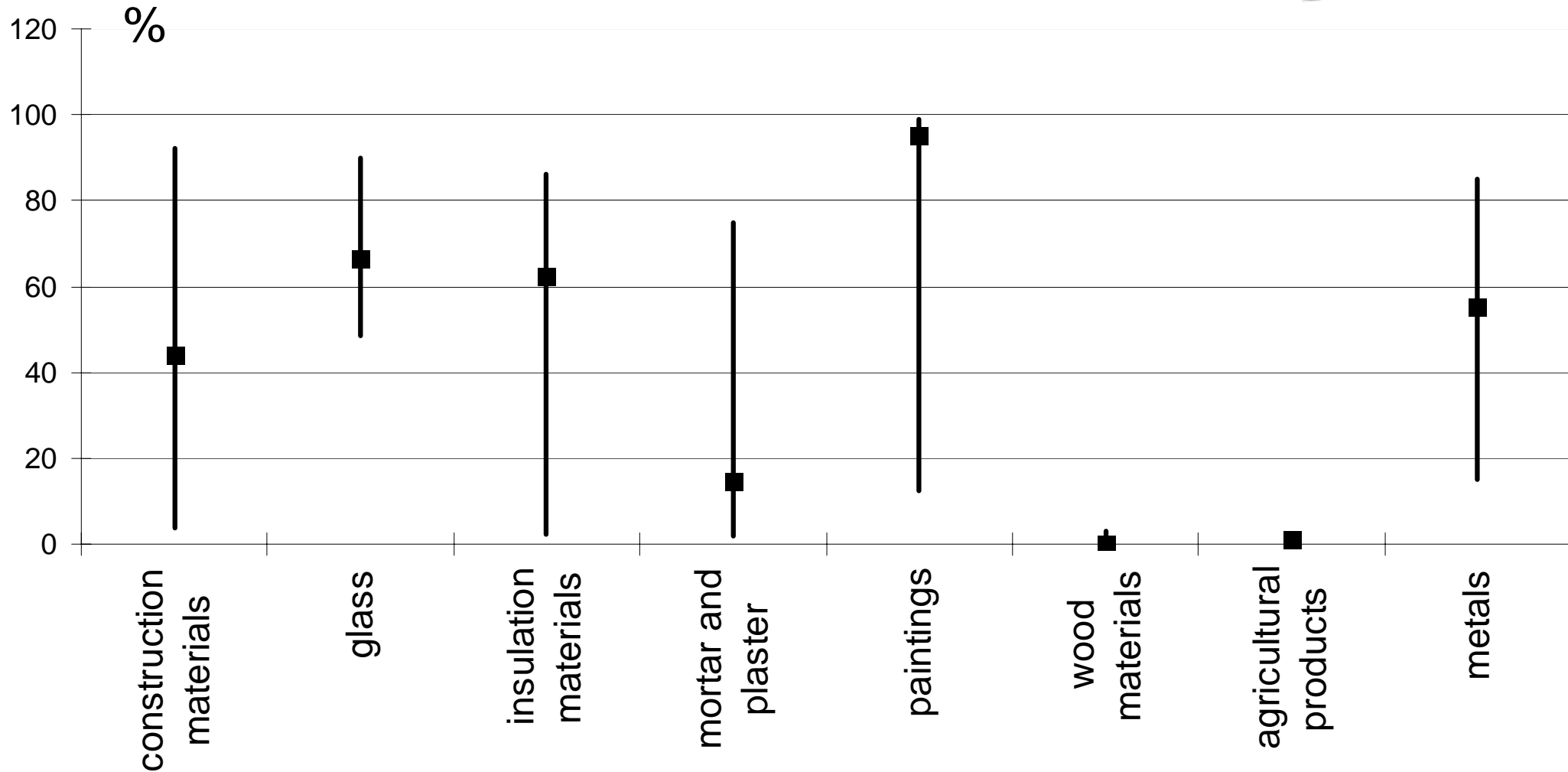
Share of capital goods on total impacts: Land competition



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Share of capital goods on total impacts: Land competition



Synthesis

	land use	mineral resources	non renewable CED	climate change	acidification / eutrophication	toxicity and ecotoxicity
fossil energy	major	major	minor	minor	minor	substantial
nuclear energy	major	substantial	minor	substantial	substantial	substantial
biomass energy	minor	major	substantial	substantial	minor	substantial
renewable energy, nec	major	major	major	major	major	major
metals	substantial	minor	minor	minor	minor	minor
mineral construction materials	substantial	major	minor	minor	minor	substantial
wood products	minor	major	substantial	minor	minor	substantial
agricultural products	minor	major	substantial	minor	minor	substantial
transport services	major	major	substantial	substantial	substantial	substantial
waste incineration	substantial	major	substantial	minor	minor	minor
land filling	substantial	major	substantial	substantial	substantial	minor
waste water treatment	major	major	major	major	substantial	substantial

Discussion

- (Eco-)Toxicity related indicators show higher significance of capital goods
- Capital intensive energy systems such as wind power, hydro power and photovoltaics are dominated by capital goods' contribution, independent of the indicators
- Some indicators behave similarly across economic sectors mineral resources, acidification, eco-indicator 99 totals, to a lesser extent : climate change
- Contrasting behaviour (contribution between <1 and >98%): Freshwater ecotoxicity, land use



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Conclusions and recommendations



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- Climate change, cumulative energy demand (CED):
capital goods are a must in agriculture, transports, renewable energies, waste management
- Toxicity:
capital goods are a must
- Capital goods cannot be excluded per se
- Recommendation:
 - Share of maintenance and depreciation costs on product price (Heijungs et al. 1992)
 - identify environmental hot spots in capital goods supply chain

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