



Carbon Footprint or Full Life Cycle Assessment – does the approach matter?

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Starting Point



SUSTAINABILITY IN BUSINESS



Materials Science and Technology

LCA IN EUROPE

Carbon Footprint

A Catalyst for Life Cycle Assessment?

Bo P. Weidema, Mikkel Thrane, Per Christensen,
Jannick Schmidt, and Søren Løkke

*“Carbon footprinting has a **much broader appeal than LCA**. . . . In [carbon footprinting], things are **kept simple**, and a carbon footprint is **easy to calculate online**. . . . and the calculated value can **easily be grasped**. . . . It is certainly an eye opener when you discover that your next trip from Copenhagen to San Francisco has a carbon footprint of roughly 2t of CO₂ (equivalents), or 20% of the carbon footprint of an average European in an entire year.”*

Weidema et al. (2008)

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Starting Point

■ But ...



Starting Point

- Research question : How do analyses and results differ, if done with **Carbon Footprint** or **full single-score assessments**?



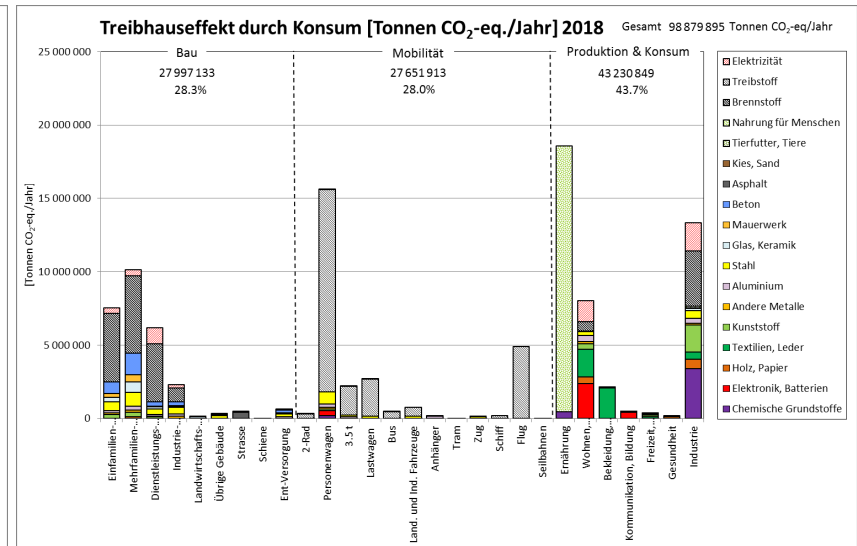
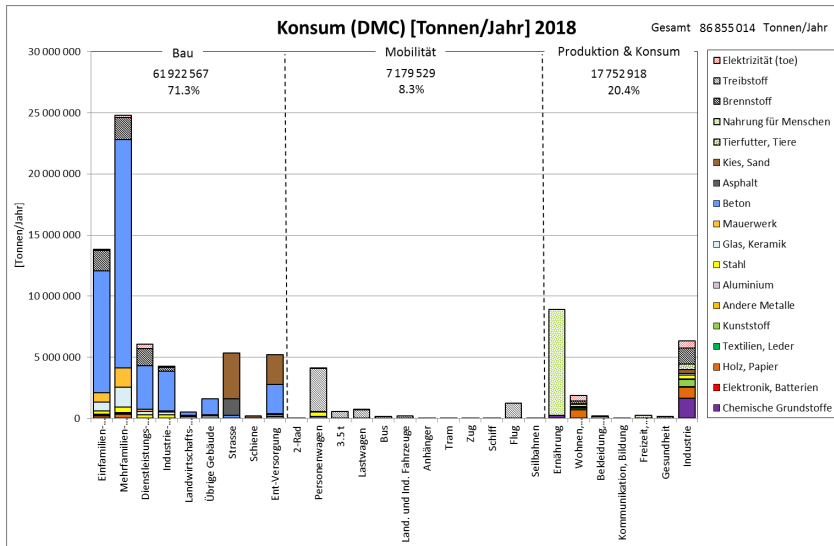
Starting Point



- **Investigation of a variety of processes** for widely used materials and services
 - Database → ecoinvent 3.8.1
 - Software → Simapro 9.4
 - Impact Assessment
 - GWP
 - Ecological Scarcity Method 2021 («UBP'21»)
 - EF Method 3.0
 - ReCiPe, Endpoints (H/A)
- } Split into GWP & all other contributions

Method and Materials

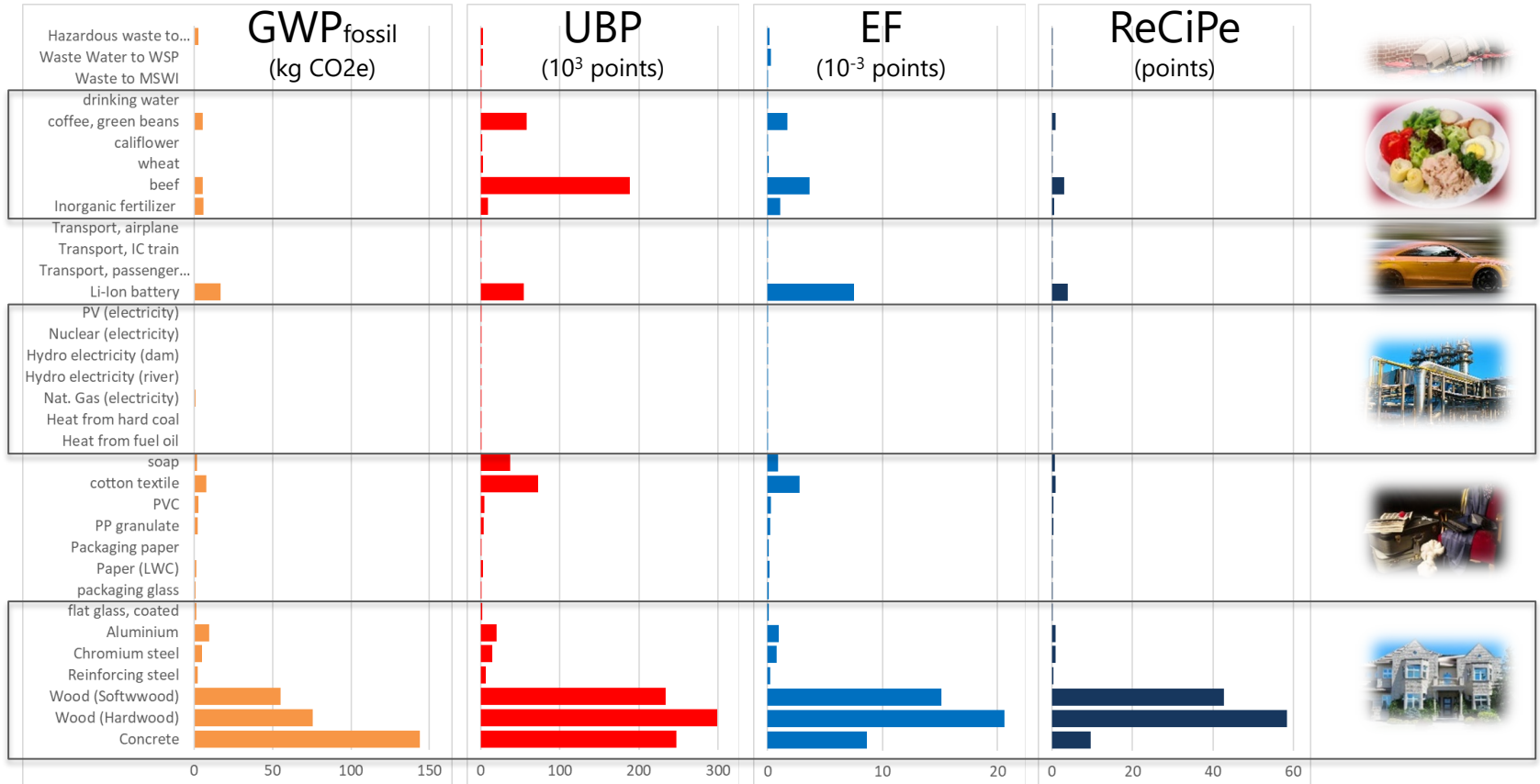
- ... our choice of materials and processes influenced by Bafu's MatCH study (Matasci et al. 2019)



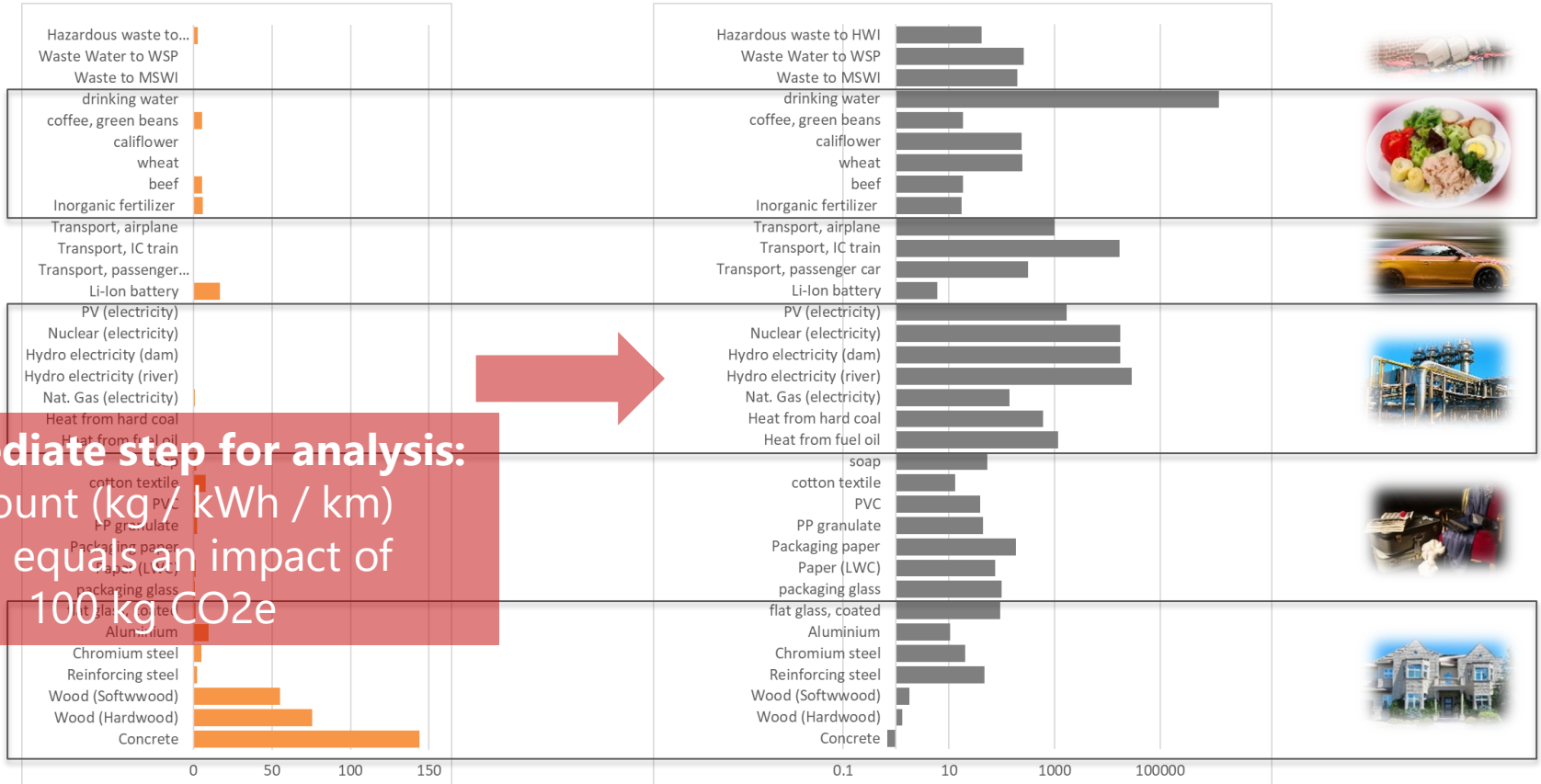
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	<p>1 m3 Concrete, normal {CH} market for 1 m3 Sawnwood, board, hardwood, dried (u=10%), planed {CH} market for sawnwood, board, hardwood, dried (u=10%), planed 1 m3 Sawnwood, board, softwood, dried (u=10%), planed {CH} market for sawnwood, board, softwood, dried (u=10%), planed 1 kg Reinforcing steel {GLO} market for 1 kg Steel, chromium steel 18/8 {GLO} market for 1 kg Aluminium, primary, ingot {IAI Area, EU27 & EFTA} market for 1 kg Flat glass, coated {RER} market for flat glass, coated</p>
	<p>1 kg Packaging glass, white {GLO} market for 1 kg Paper, woodcontaining, lightweight coated {RER} market for 1 kg Kraft paper {RER} market for kraft paper 1 kg Polypropylene, granulate {GLO} market for 1 kg Polyvinylchloride, bulk polymerised {GLO} market for 1 kg Textile, knit cotton {GLO} market for 1 kg Soap {GLO} market for</p>
	<p>1 MJ Heat, central or small-scale, other than natural gas {CH} heat production, light fuel oil, at boiler 100kW condensing, non-modulating 1 MJ Heat, central or small-scale, other than natural gas {Europe without Switzerland} heat production, hard coal briquette, stove 5-15kW 1 kWh Electricity, high voltage {CH} electricity production, natural gas, 10MW 1 kWh Electricity, high voltage {CH} electricity production, hydro, run-of-river 1 kWh Electricity, high voltage {CH} electricity production, hydro, reservoir, alpine region 1 kWh Electricity, high voltage {CH} electricity production, nuclear, boiling water reactor 1 kWh Electricity, low voltage {CH} electricity production, photovoltaic, 3kWp slanted-roof installation, a-Si, laminated, integrated</p>
	<p>1 kg Battery, Li-ion, NMC111, rechargeable, prismatic {GLO} market for battery, Li-ion, NMC111, rechargeable, prismatic 1 km Transport, passenger car, EURO 5 {RER} market for 1 personkm Transport, passenger train {CH} long-distance 1 personkm Transport, passenger aircraft, medium haul {GLO} market for transport, passenger aircraft, medium haul</p>
	<p>1 kg Inorganic nitrogen fertiliser, as N {CH} market for inorganic nitrogen fertiliser, as N 1 kg Red meat, live weight {GLO} market for 1 kg Wheat grain, Swiss integrated production {CH} market for wheat grain, Swiss integrated production 1 kg Cauliflower {GLO} market for 1 kg Coffee, green bean {GLO} market for coffee, green bean 1 kg Tap water {CH} market for</p>
	<p>1 kg Municipal solid waste {CH} treatment of, municipal incineration with fly ash extraction 1 m3 Wastewater, average {CH} treatment of, capacity 1E9l/year 1 kg Hazardous waste, for incineration {CH} treatment of hazardous waste, hazardous waste incineration</p>

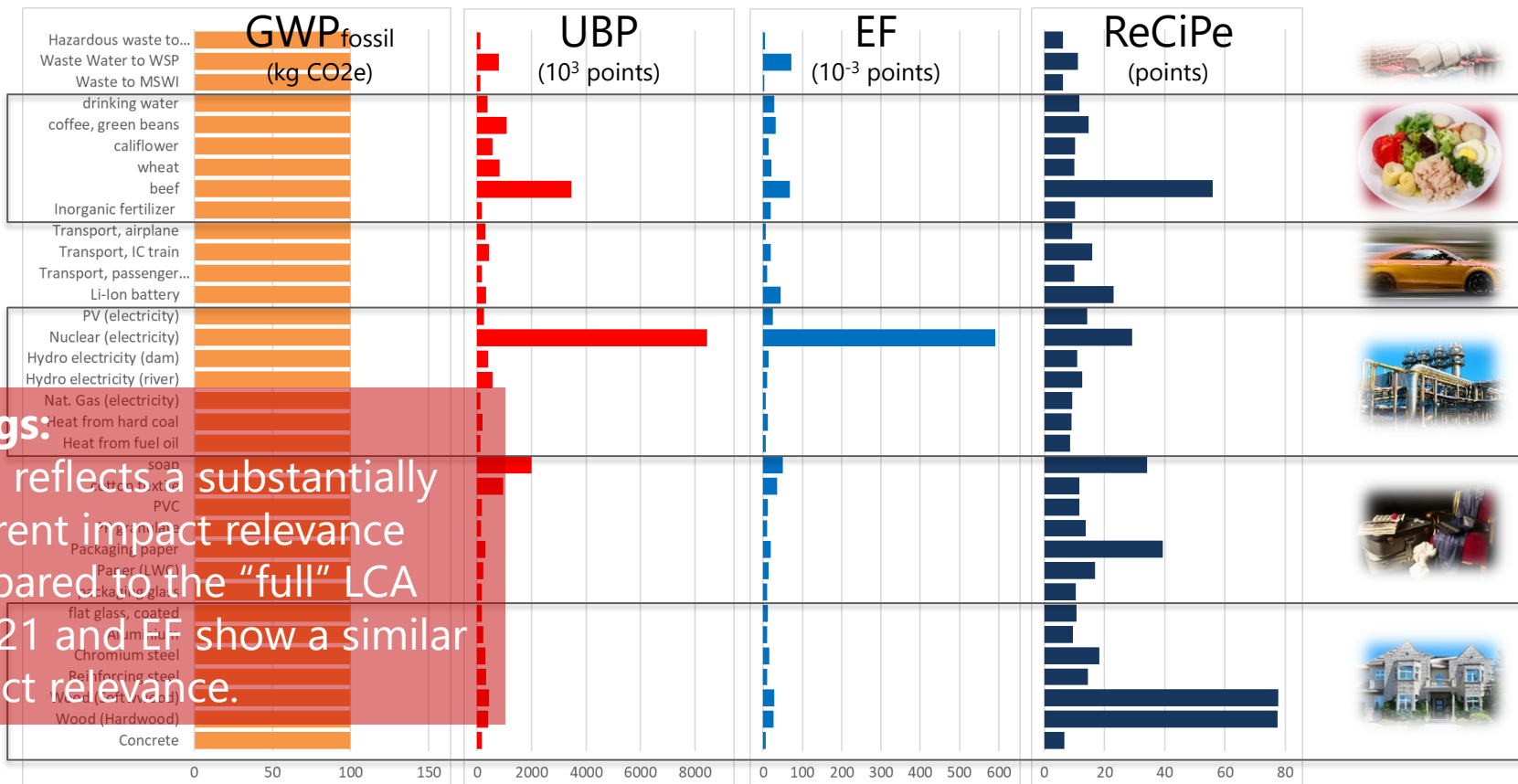
Results



Results



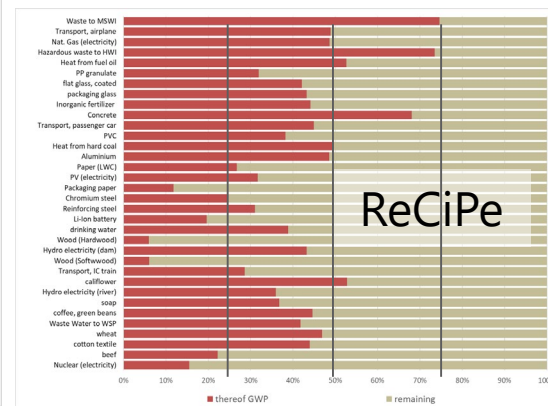
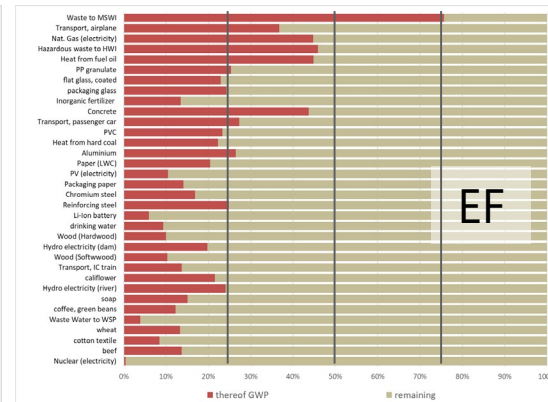
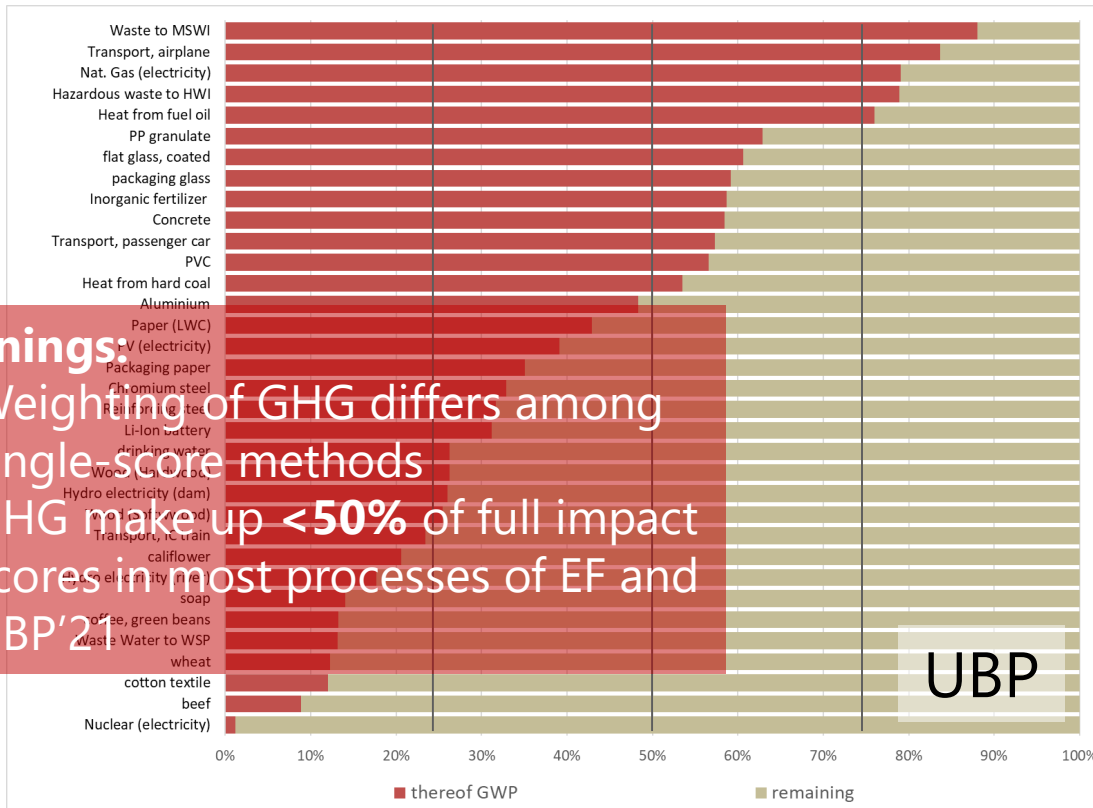
Results



Learnings:

- a) GWP reflects a substantially different impact relevance compared to the "full" LCA
- b) UBP'21 and EF show a similar impact relevance.

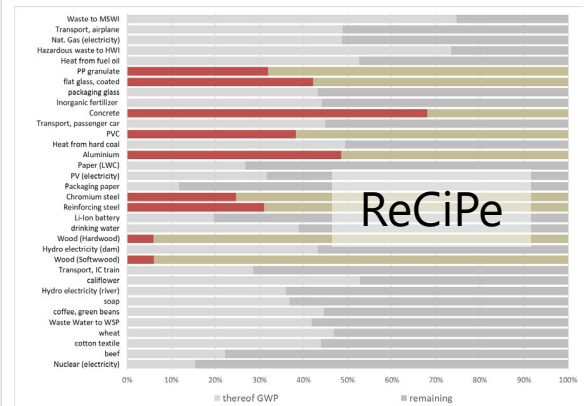
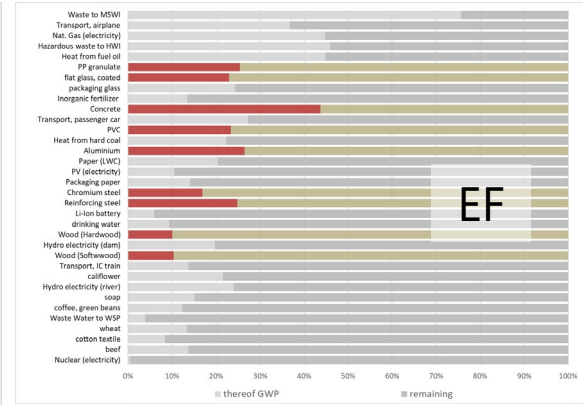
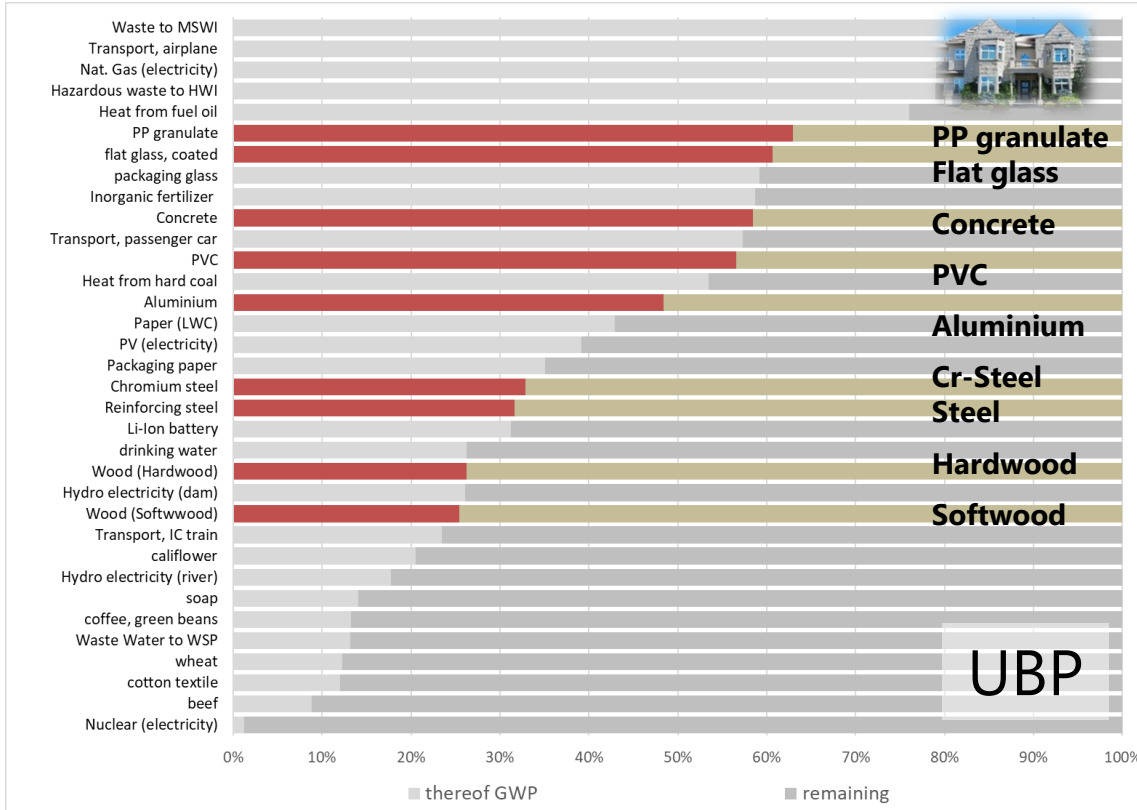
Contribution Analysis GHG



Learnings
 a) Weighting of GHG differs among single-score methods
 b) GHG make up <50% of full impact scores in most processes of EF and UBP'21

UBP

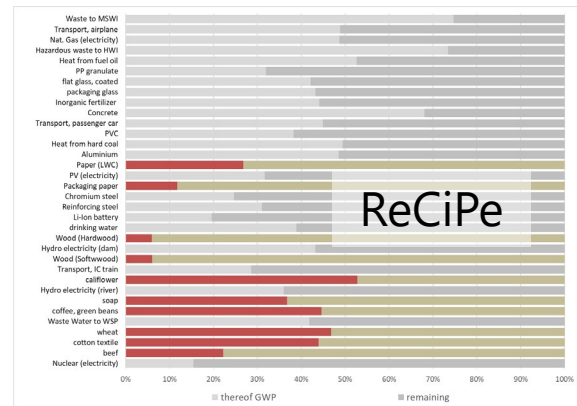
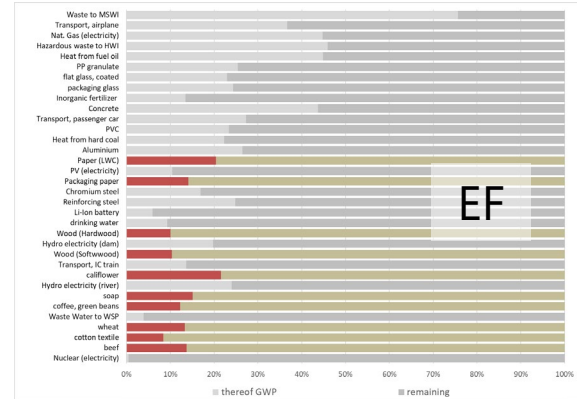
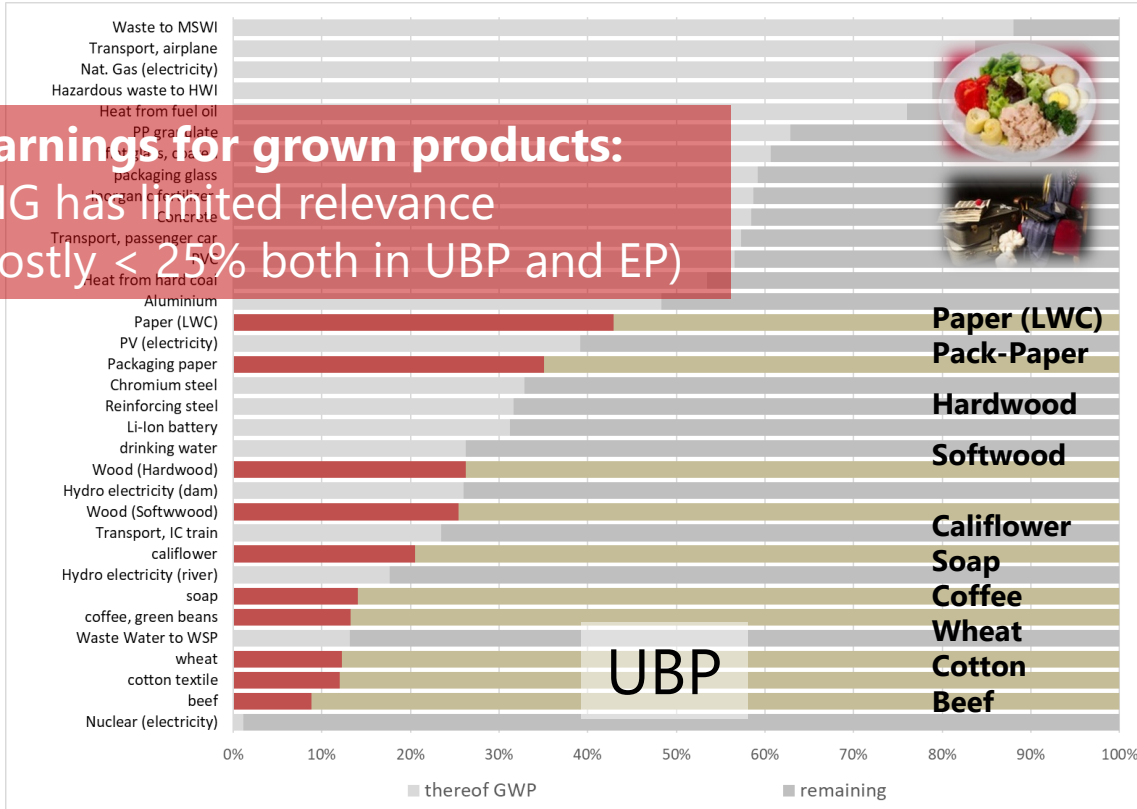
Construction Materials (incl. Plastics)



Food & Biomaterials

Contribution Analysis GHG

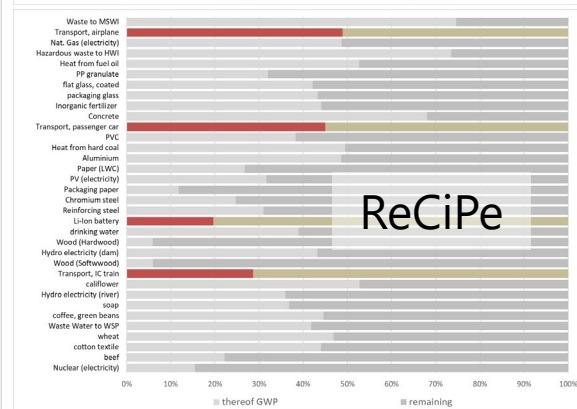
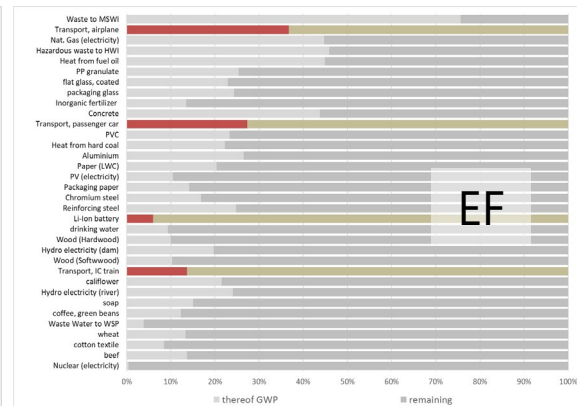
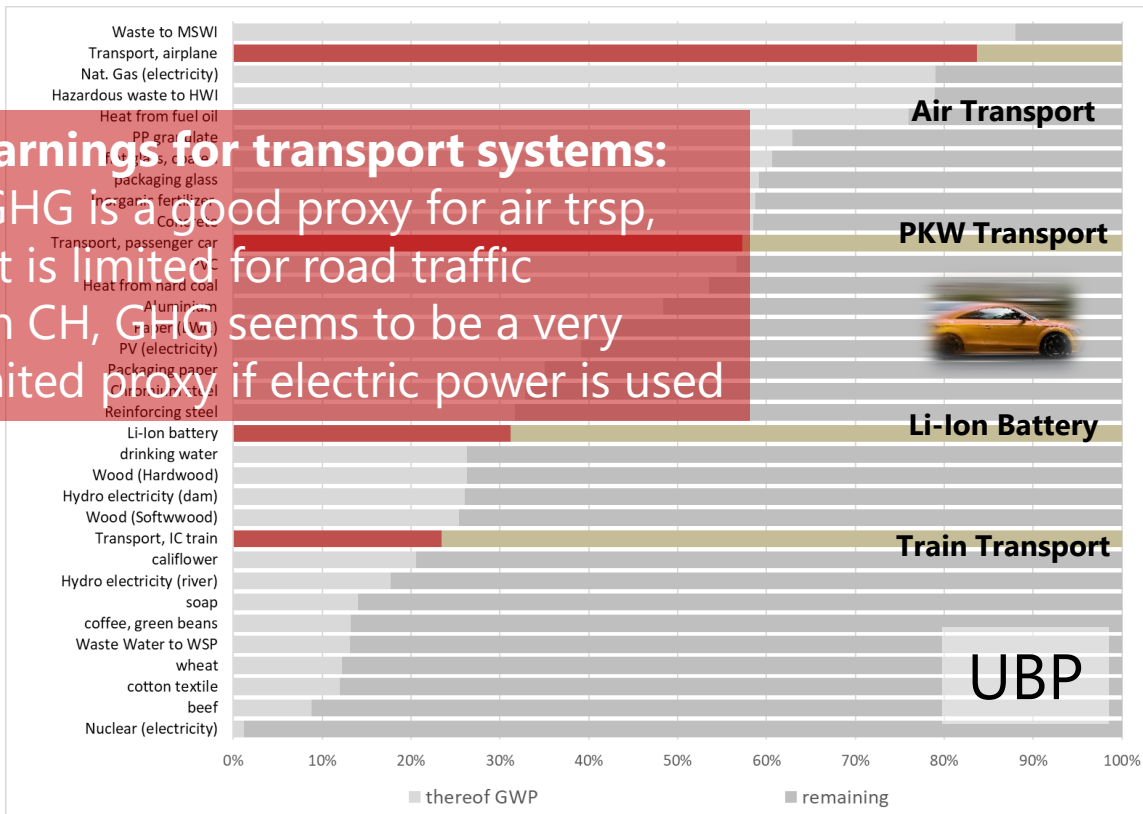
Learnings for grown products:
GHG has limited relevance
(mostly < 25% both in UBP and EP)



Transport

Contribution Analysis GHG

Learnings for transport systems:
 .. GHG is a good proxy for air trsp,
 but is limited for road traffic
 .. In CH, GHG seems to be a very
 limited proxy if electric power is used



Conclusions

- Full LCIA methods differ in their weighting (= relevance) of GHG
- Share of GHG in the full LCIA varies **from 1% to almost 90%**
- EU-EF and CH-UBP'21 often give GHG a similar weight
- Some, few sector-related patterns
- And: huge range of GHG-share of total impact makes **GHG a bad proxy!**
- A full LCIA yields a more comprehensive analysis
- We don't address which approach(es) are most adequate and consistent
- But a «GHG-only analysis» is strongly incomplete
- **Yes, the assessment approach matters!**
- We propose to call a GHG-only LCIA a «2nd best» or «limited LCA»



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