



LCA of biopolymers – SYNPOL case study



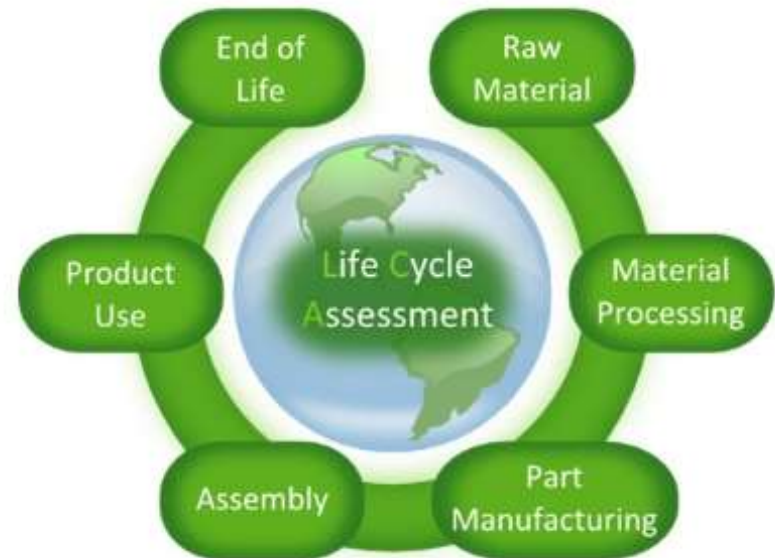
Kamila Mascart, Madrid, 9 September 2016

AGENDA

1. LCA methodology
2. Biopolymers – definition and examples
3. Biopolymers – life cycle and examples (incl. SYNPOL)
4. Conclusions

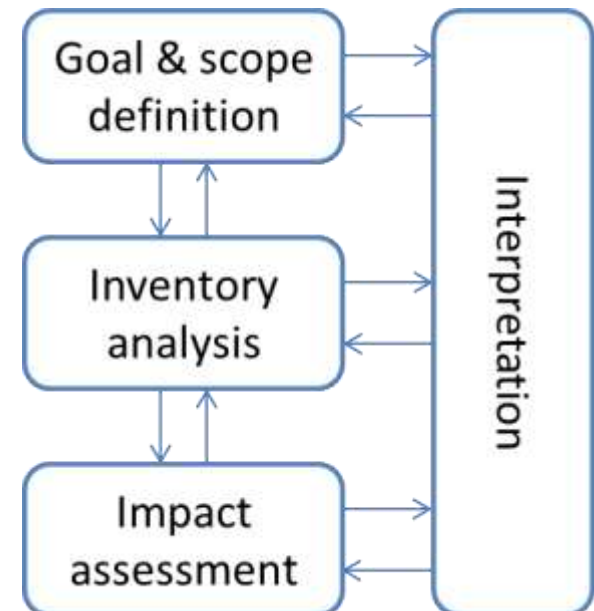
LIFE CYCLE ASSESSMENT (LCA)

- Cradle-to-grave (incl. waste treatment)
- Cradle-to-gate (certain point, e.g. factory gate)
- Cradle-to-cradle (incl. recycling)
- Gate-to-gate (limited part)
- Guidelines
 - ISO 14040/14044
 - ILCD Handbook
- Standard methodology
 - ILCD 2011 Midpoint+
 - ReCiPe Midpoint & Endpoint
 - IPCC 2013
- Ecoinvent database



LCA EXAMPLE

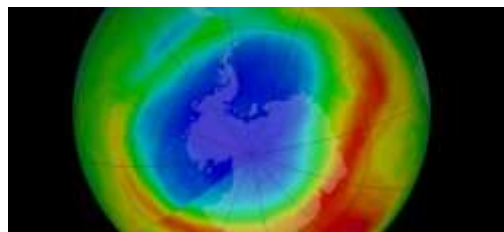
- What do we want to know?
 - Functional unit (FU): 5 pancakes
- What are in- and outputs?
 - Data inventory throughout the life cycle (preparation, baking, etc.): flour, eggs, milk, heat, CO₂ emissions, ...)
- What is the impact on the environment?
 - Just climate change
 - or 16 impact categories
- Reference scenario
 - Functional equivalent (e.g. fruit salad)



IMPACT CATEGORIES

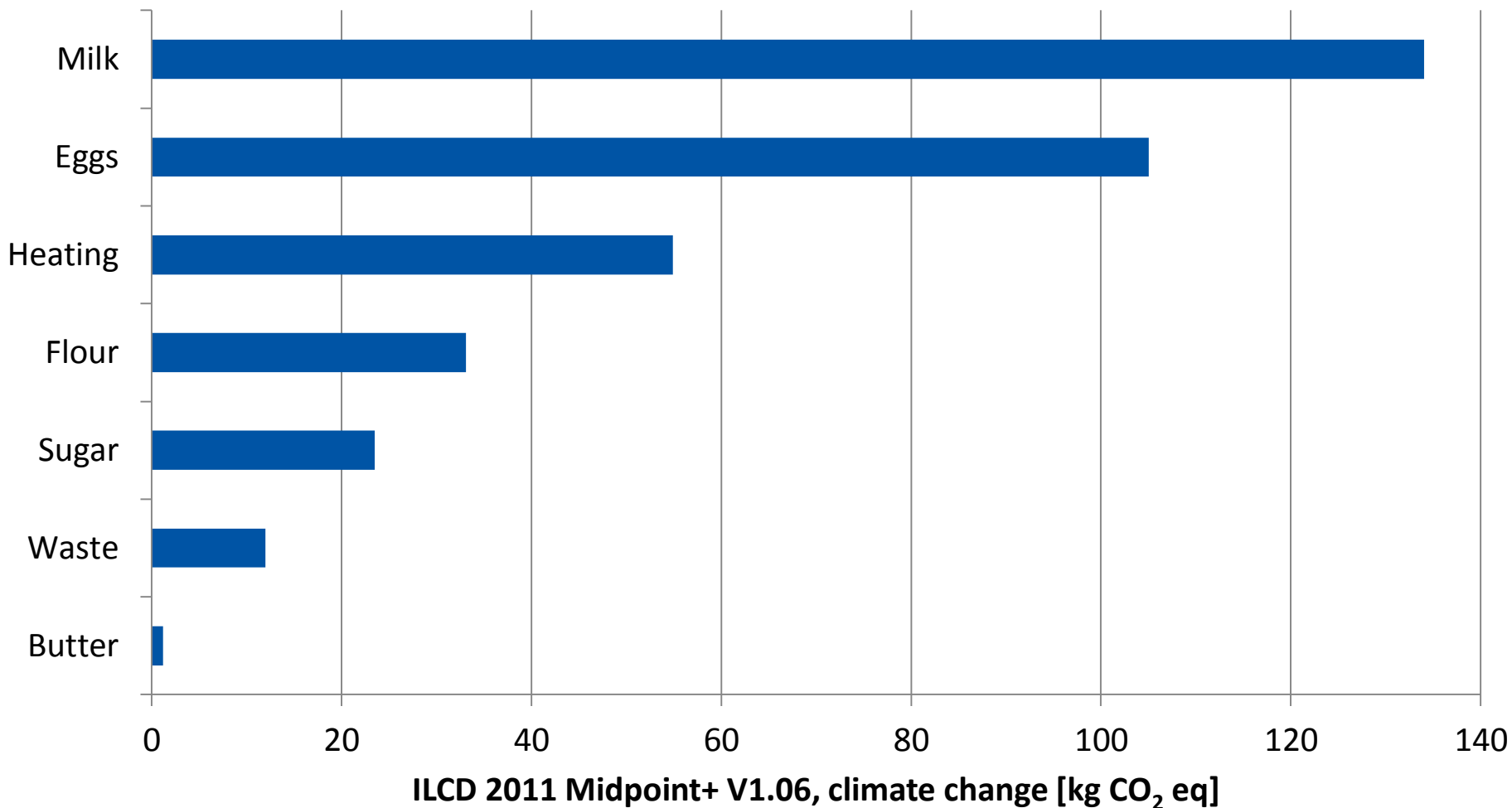


- Effect category
- Climate change
- Ozone depletion
- Human toxicity, non-cancer effects
- Human toxicity, cancer effects
- Particulate matter
- Ionizing radiation HH
- Ionizing radiation E
- Photochemical ozone formation
- Acidification
- Terrestrial eutrophication
- Freshwater eutrophication
- Marine eutrophication
- Freshwater ecotoxicity
- Land use
- Water resource depletion
- Mineral, fossil & renewable resource depletion



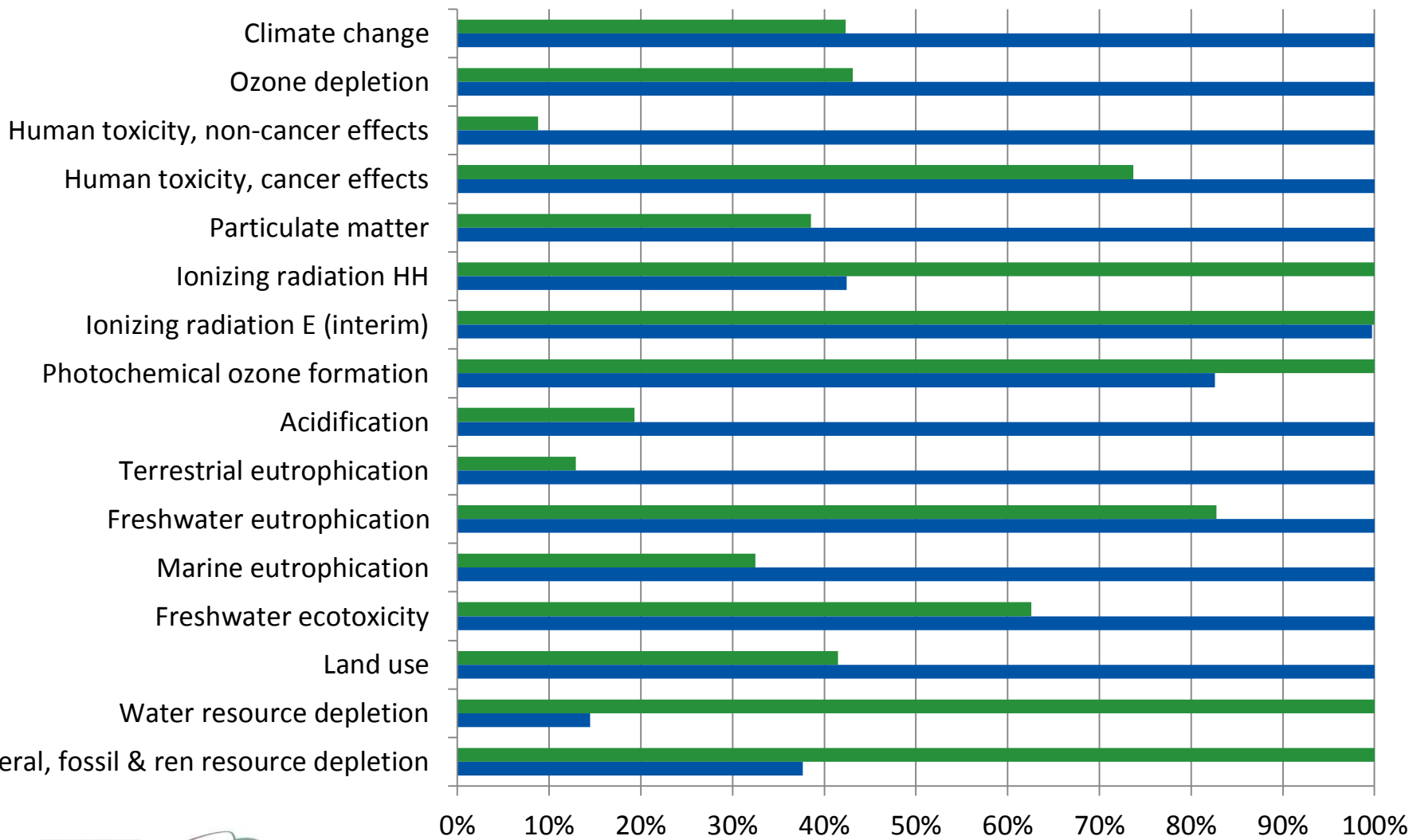
CLIMATE CHANGE IMPACT

Climate change impact of 5 pancakes



COMPARISON WITH REFERENCE

■ Fruit salad ■ Pancakes



What are BIOPOLYMERS?

- Polymers produced by living organisms (Cellulose, Lignin, Starch, ...)
- Polymers as materials – mainly packaging (PLA, TPS, PHA, Bio-PE, ...)

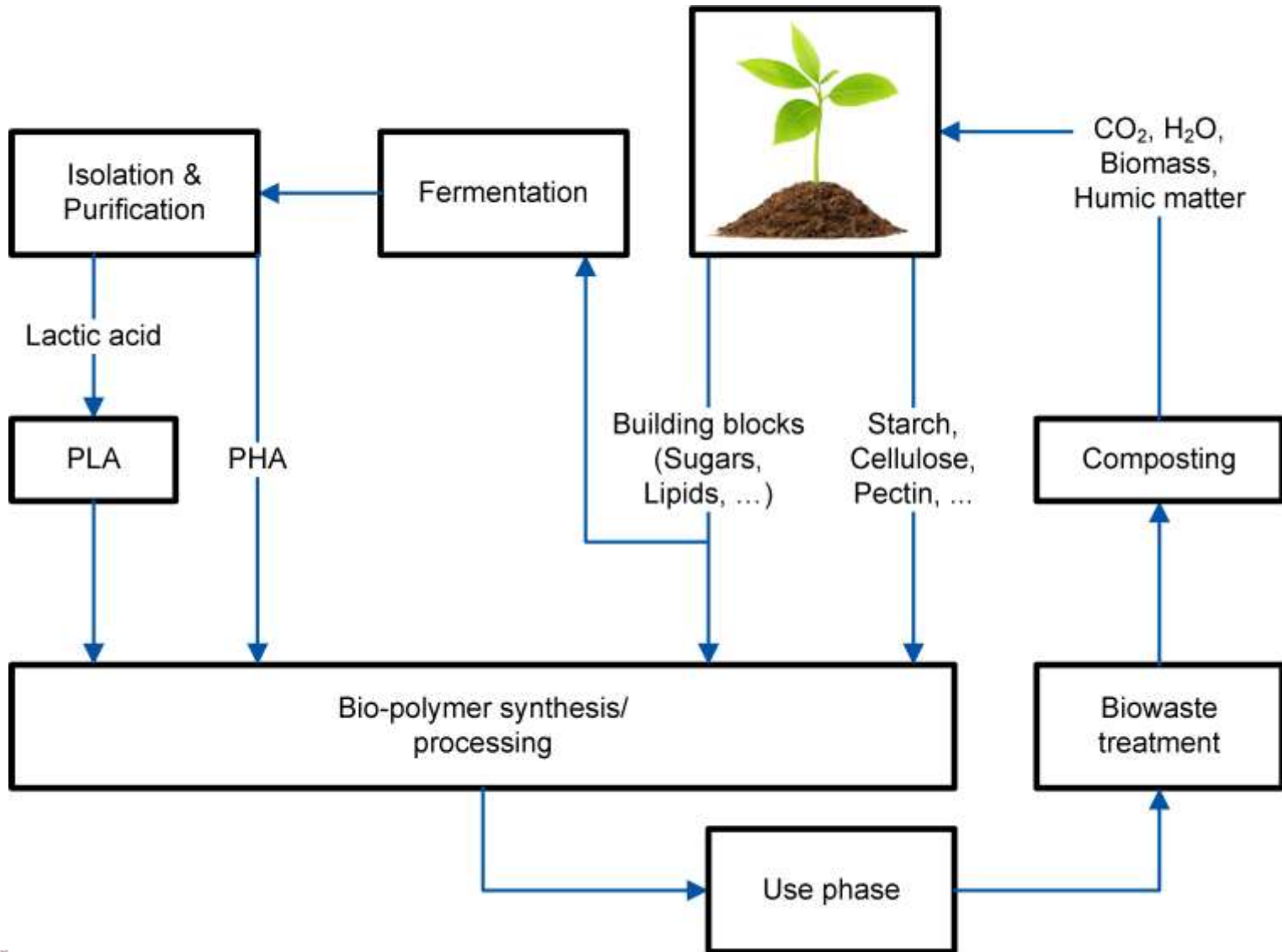
Biopolymer = Biodegradable (PLA, PHA, TPS)

Biopolymer ≠ Biodegradable (BioPE, BioPET)

Biopolymer = Biobased (PLA, PHA, TPS)

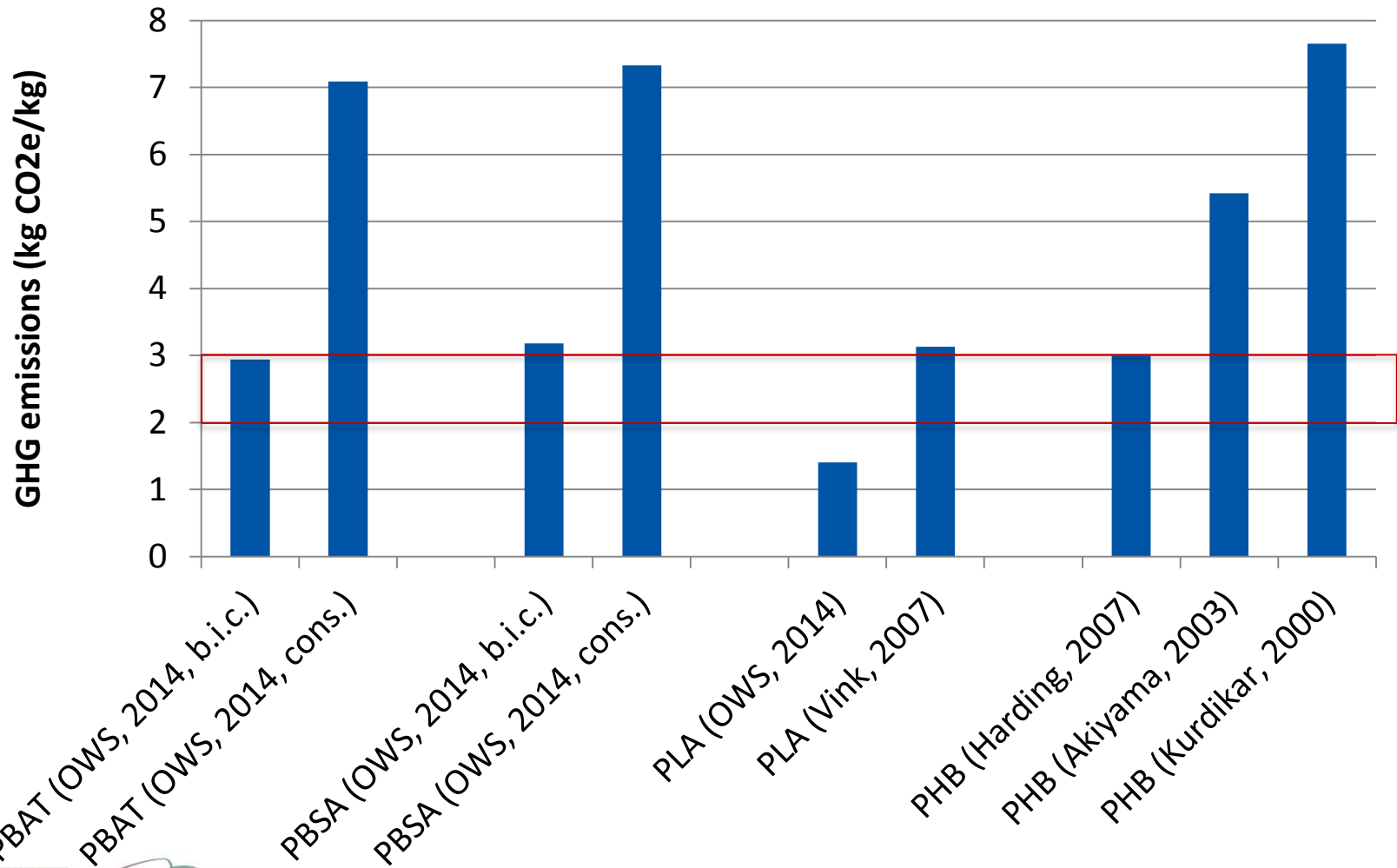
Biopolymer ≠ Biobased (PBAT, PBS, PCL)

LIFE CYCLE – BIOBASED POLYMERS



BIOPOLYMERS – IMPACT ON CLIMATE CHANGE

GHG emissions PBAT, PBS, PBSA, PLA and PHB production

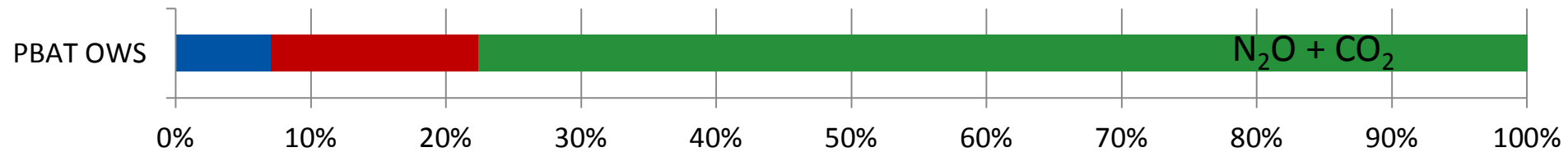


BIOPOLYMERS VS CONVENTIONAL POLYMERS

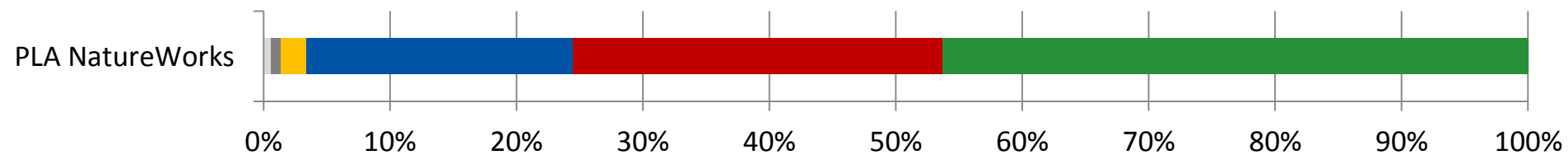
- Data for modelling – difficult to obtain, often confidential
- Production process not mature enough (PE = +50 y. VS PLA = 15 y.)
- Much smaller production scale (about 20% of all polymeric materials)
- Big impact of feedstock (possible solution: 2nd and 3rd generation feedstocks)
- Big impact of fermentation and extraction (a lot of room for improvement)

BIOPOLYMERS – HOT SPOTS – CLIMATE CHANGE

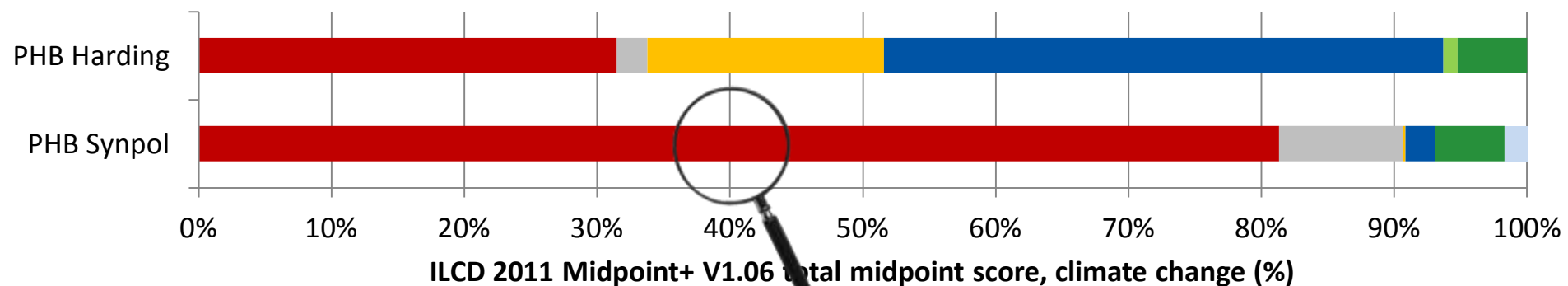
■ Terephthalic acid ■ Butane-1,4-diol ■ Adipic acid



■ Waste ■ Wastewater ■ Chemical factory ■ Heat ■ Maize grain ■ Electricity



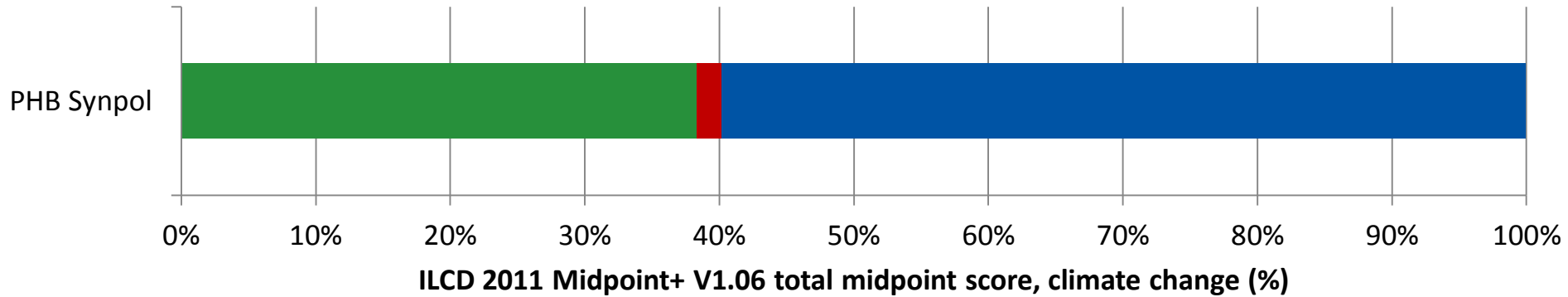
■ Fermentation broth ■ Chemicals ■ Electricity ■ Heat ■ Wastewater ■ Waste ■ Emissions



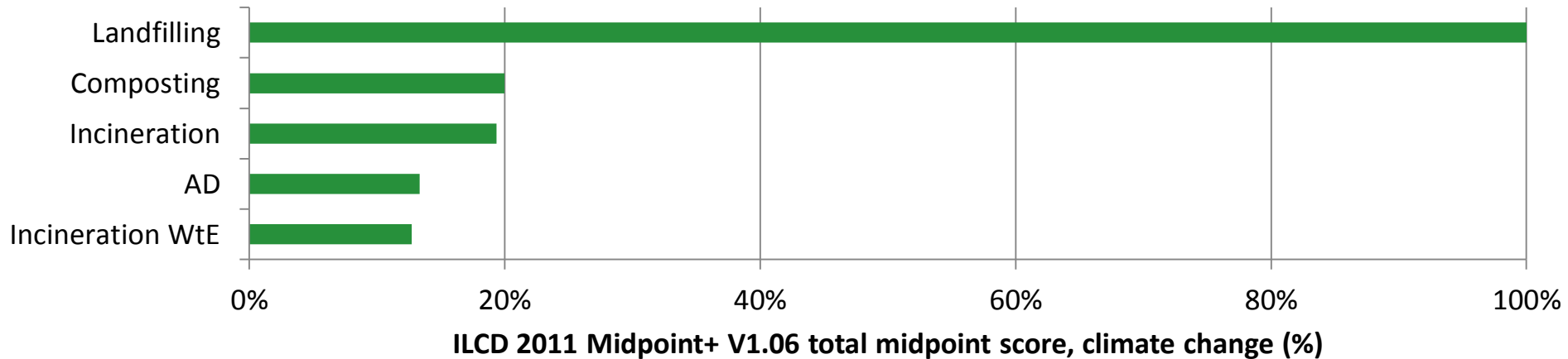
PHB SYNPOL – HOT SPOTS CLIMATE CHANGE & EOL

PHB fermentation

■ MIP MSWd ■ Growth medium ■ Flaring

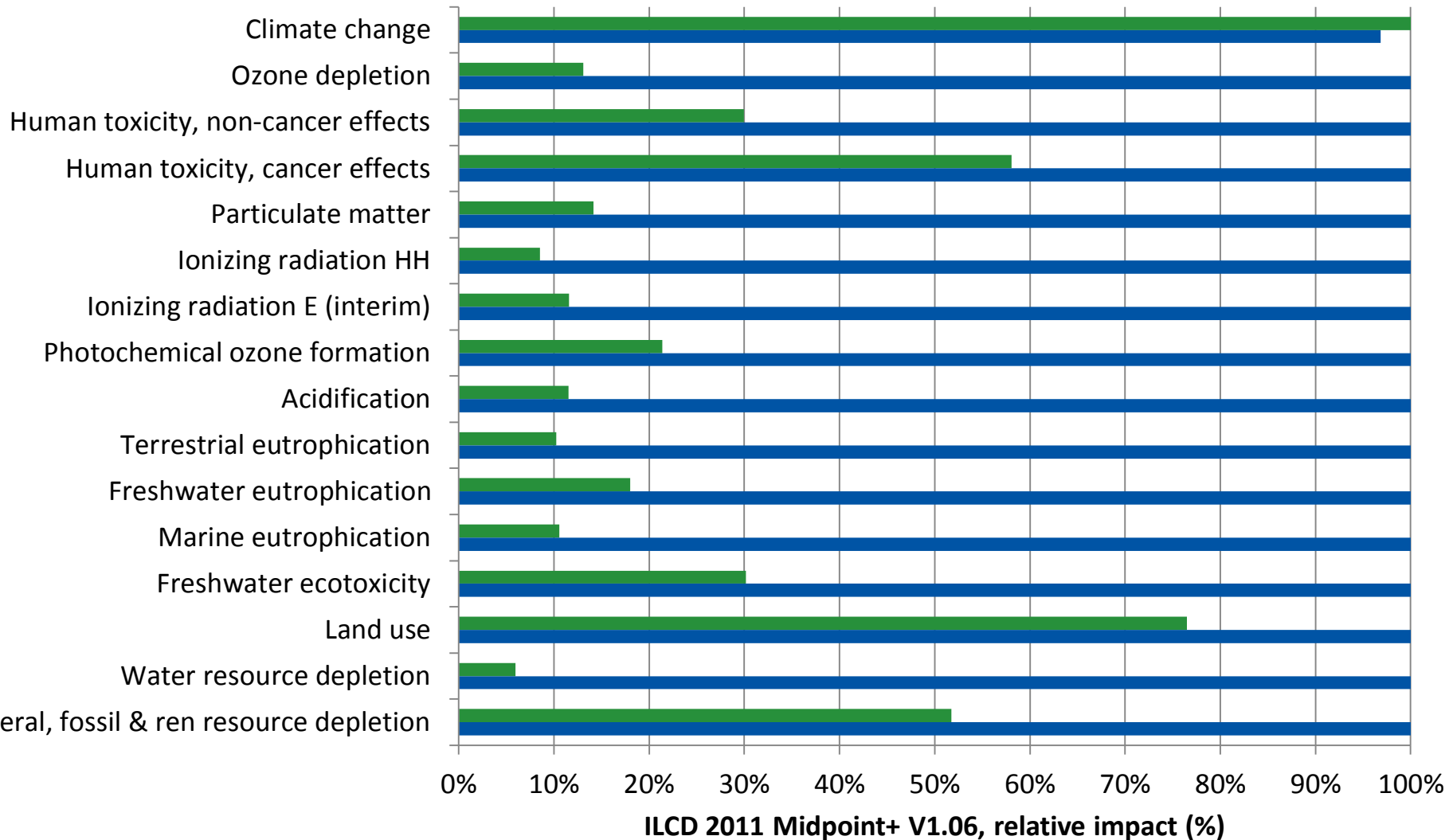


PHB Synpol EOL



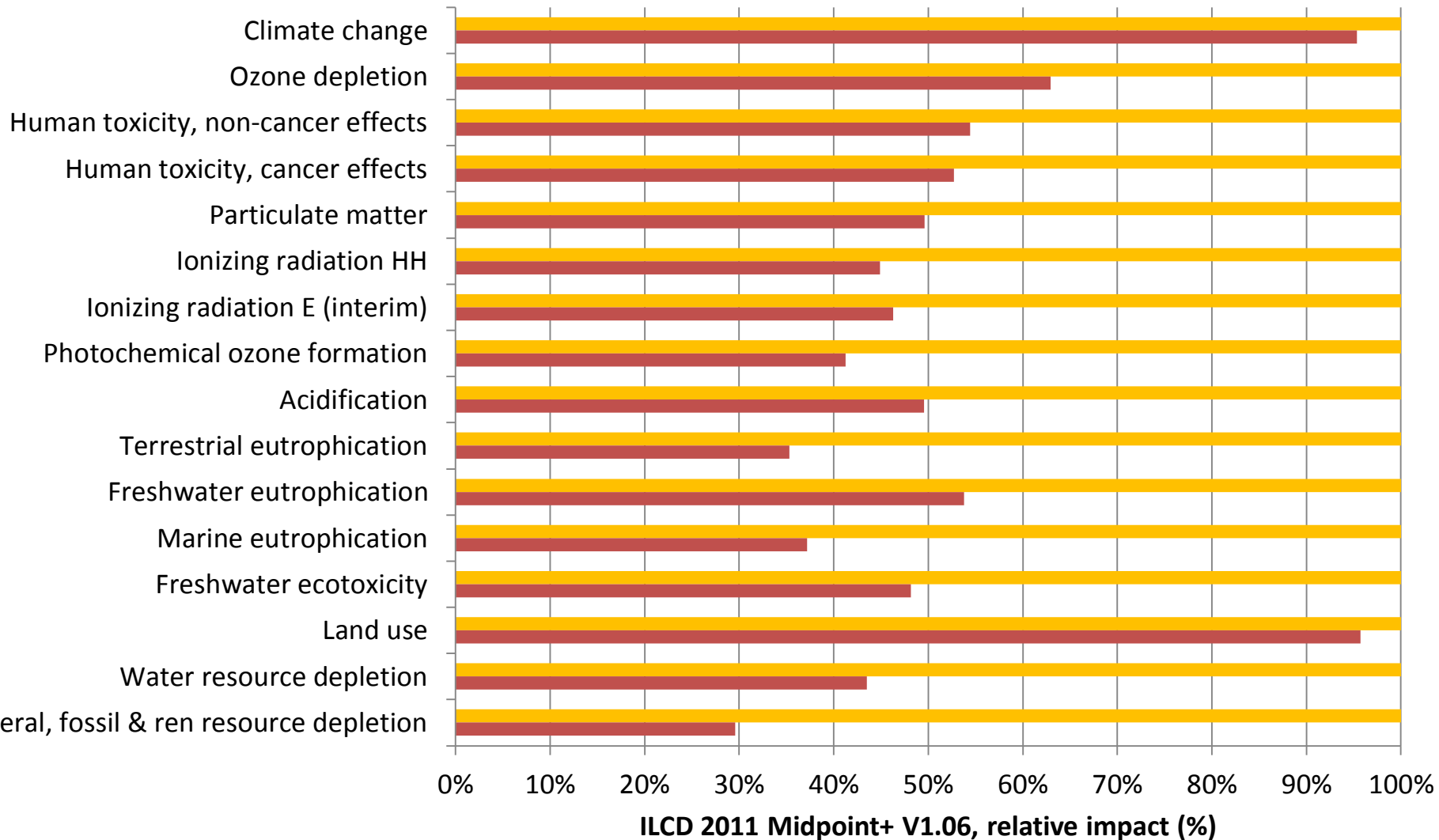
PHB SYNPOL – COMPOSTING VS INCINERATION

■ Composting ■ Incineration



PHB SYNPOL – AD VS INCINERATION WTE

■ AD ■ Incineration WtE



CONCLUSIONS

- LCA – impact on climate change most popular, but not the only assessment parameter
 - 16 impact categories according to ILCD Midpoint method
- Biopolymers – Biobased **AND/OR** Biodegradable
- Biopolymers production hotspots (general):
 - Electricity, Feedstock
- Biopolymers – production technologies – need for optimization
- PHB Synpol production hotspots:
 - Feedstock (pyrolysis), Emissions (Gas flaring)
- EOL PHB: **AD best**, **Landfilling worst**
 - AD>WtE>Composting>Incineration>Landfilling

THANK YOU

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