

Selected bio-product LCA around the world: results and applications

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Contents

- Range of bio-based products
- Policy relevance and role of LCA
- Case studies
- Caveats
- Conclusions



Bio-based products

- Starches, oil, cellulose
- Amino acids...
- Polymers, solvents, surfactants, lubricants
- Biofuels (not discussed in this talk)
- Traditional : paper, fabrics (not discussed)

Policy worldwide

○ US BioPreferred program : energy security

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Product Categories

USDA designates categories of biobased products for a Federal Procurement preference. In the process, minimum biobased content standards are established for each product category.

There are 97 BioPreferred® designated product categories required for preferred Federal purchasing.

Product Categories by Functional Area

Final

Round 1

- Bedding, Bed Linens, and Towels
 - (1) Bedding is that group of woven cloth products used as coverings on a bed. Bedding includes products such as blankets, bedspreads, comforters, and quilts.
 - (2) Bed linens are woven cloth sheets and pillowcases used in bedding.
 - (3) Towels are woven cloth products used primarily for drying and wiping.

12% - Minimum Biobased Content

- Diesel Fuel Additives
- Hydraulic Fluids - Mobile Equipment
- Penetrating Lubricants
- Roof Coatings
- Water Tank Coatings

Round 2

- Adhesive and Mastic Removers
- Composite Panels - Acoustical
- Composite Panels - Interior Panels
- Composite Panels - Plastic Lumber
- Composite Panels - Structural Interior Panels
- Composite Panels - Structural Wall Panels
- Disposable Containers
- Fertilizers
 - Products formulated or processed to provide nutrients for plant growth and/or beneficial bacteria to convert nutrients into plant usable forms. Biobased fertilizers, which are likely to consist mostly of biobased components, may include both biobased and chemical components.

71% - Minimum Biobased Content

- Fluid-Filled Transformers - Synthetic Ester-Based
- Fluid-Filled Transformers - Vegetable Oil-Based
- Graffiti and Grease Removers
 - Industrial solvent products formulated to remove automotive, industrial, or kitchen soils and oils, including grease, paint, and other coatings, from hard surfaces.

34% - Minimum Biobased Content

- Hand Cleaners and Sanitizers - Hand Cleaners
- Hand Cleaners and Sanitizers - Hand Sanitizers



Policy worldwide (US)

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US Policy : public forum

Water Intake

- By completing an environmental footprint or LCA and by making a comparison of performance characteristics, it can be determined if the biobased product is better than a fossil-energy based one.
- Is higher biobased content always better?
 - No, it may be worse - determined by the LCA.
 - Increased biobased content often degrades product performance.
 - **Environmental footprint and product performance are much more important drivers of product selection.**

Conclusion: I think the general consensus at the meeting was "Yes", the USDA has an obligation to provide environmental impact data about the product on the label to match consumer expectations. A USDA representative indicated that the label will more than likely have content describing exactly what the label means...instead of using just a logo.

Policy worldwide

- US BioPreferred program : energy security
- EU Bioeconomy : climate change

Policy worldwide (EC) COM(2012)60

international cooperation efforts of the EU and Member States and reach out to international organisations.

2.3. Enhancement of markets and competitiveness in bioeconomy

9. Provide the knowledge-base for sustainable intensification of primary production. Improve the understanding of current, potential and future availability and demand of biomass (including agricultural and forestry residues and waste) across sectors, taking into account added value, sustainability, soil fertility and climate mitigation potential. Make these findings available for the development and review of relevant policies. Support the future development of an agreed methodology for the calculation of environmental footprints, e.g. using life cycle assessments (LCAs)
10. Promote the setting up of networks with the required logistics for integrated and diversified biorefineries, demonstration and pilot plants across Europe, including the

OECD

- Biobased products sustainability assessment : best practice recommendations

Environmental assessment

Life Cycle Assessment (LCA) is considered to be the assessment tool for assessing the potential environmental impacts of products. Bio-based content (^{14}C measurement) on its own is insufficient. The fact that a product is bio-based is not alone a proof of its environmental sustainability.

OECD

5. Facilitate the development and adoption of international sustainability indicators for Bio-based Products that are science-based, unambiguous and validated. These should take into account factors such as:

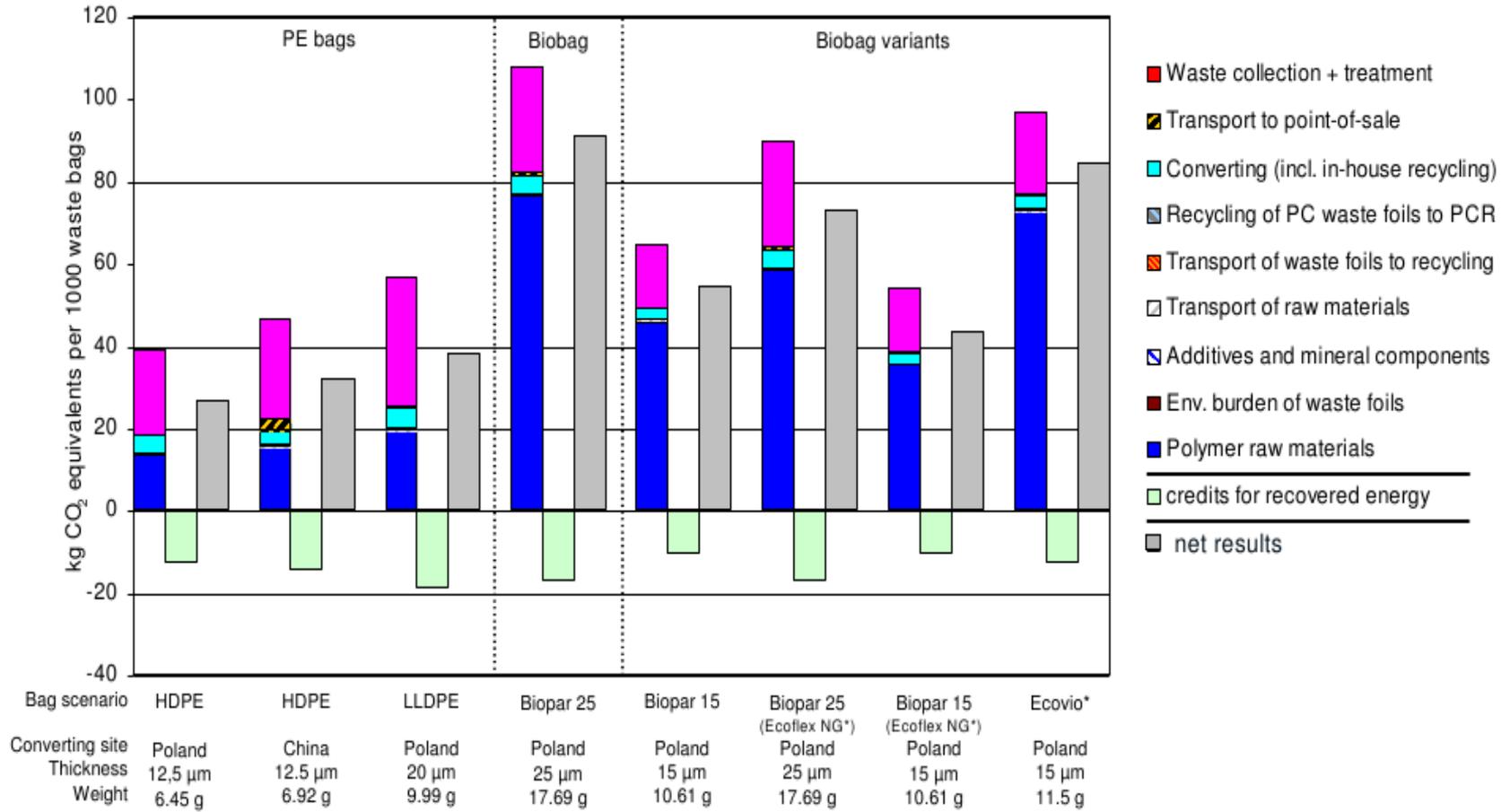
- i) Energy balance, including non-renewable and renewable energy use.
- ii) All greenhouse gas reduction over product life cycles.
- iii) Bio-based content as an indicator of renewability.
- iv) Anticipated product life.
- v) Water and solvent use during the different stages of production, and impacts on biodiversity during feedstock production and subsequent processing.
- vi) Direct and indirect land use for feedstock production.
- vii) All aspects of end of product life.
- viii) Conventional as opposed to alternative bio-based production economics.
- ix) Impact on human and environmental health.

Bio-based LCA : Case I

- Waste bags (IFEU, 2009)
- Comparison of (partly) bio-based plastics with conventional HDPE and LLDPE
- In response to attempts by EU countries (e.g. France) to ban non-**biodegradable** plastic bags

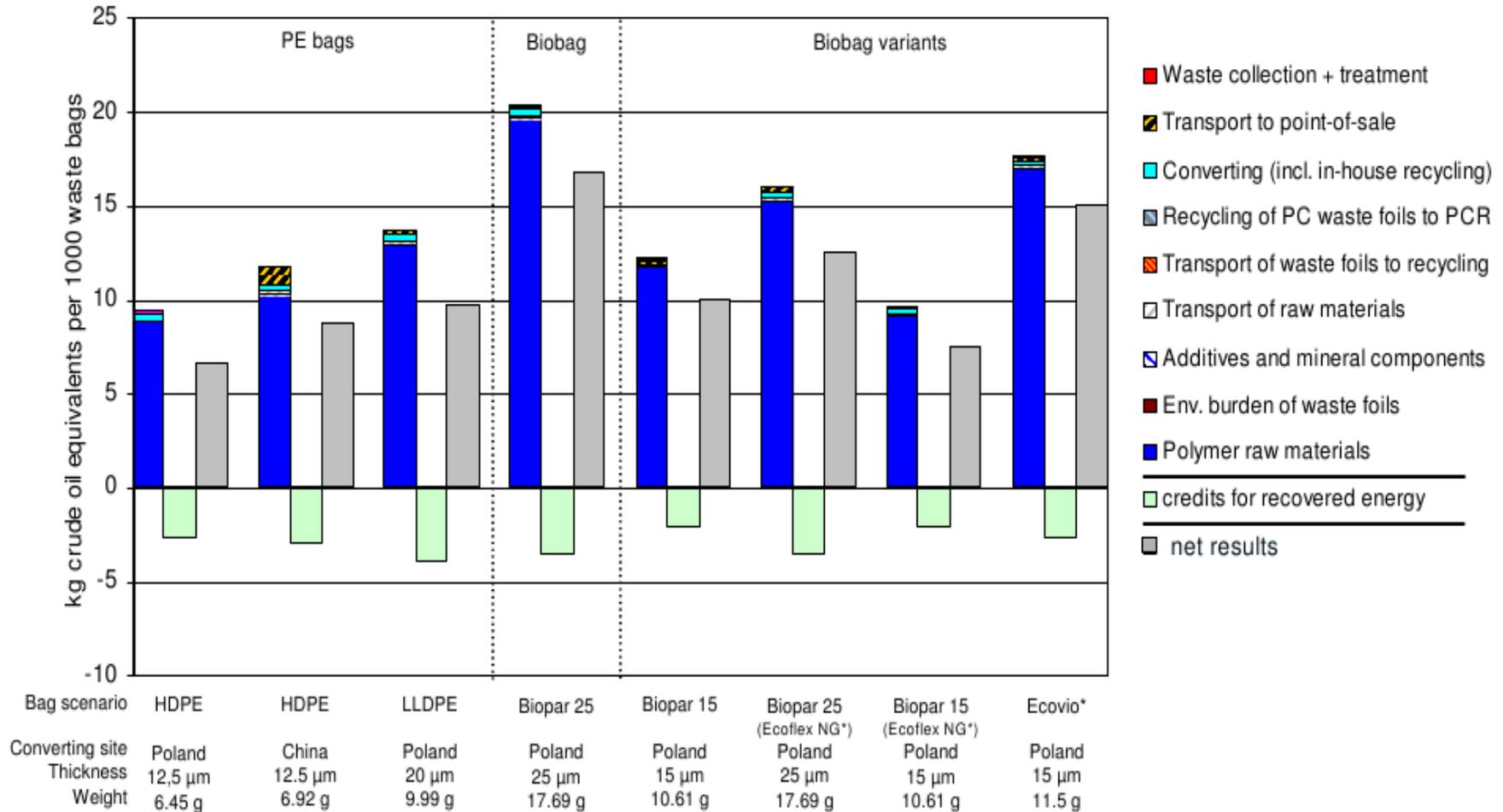
Bio-based LCA : Case I

Climate Change



Bio-based LCA : Case I

Fossil Resources



Bio-based LCA : Case I

- European Commission decided ban on non-biodegradable bags not in line with EU legislation

EU Environment Ministers discussed the issue both at the Environment Council of 14 March and 19 December 2011. On these occasions, a large number of Member States invited the Commission to assess the scope for action at EU level⁴.

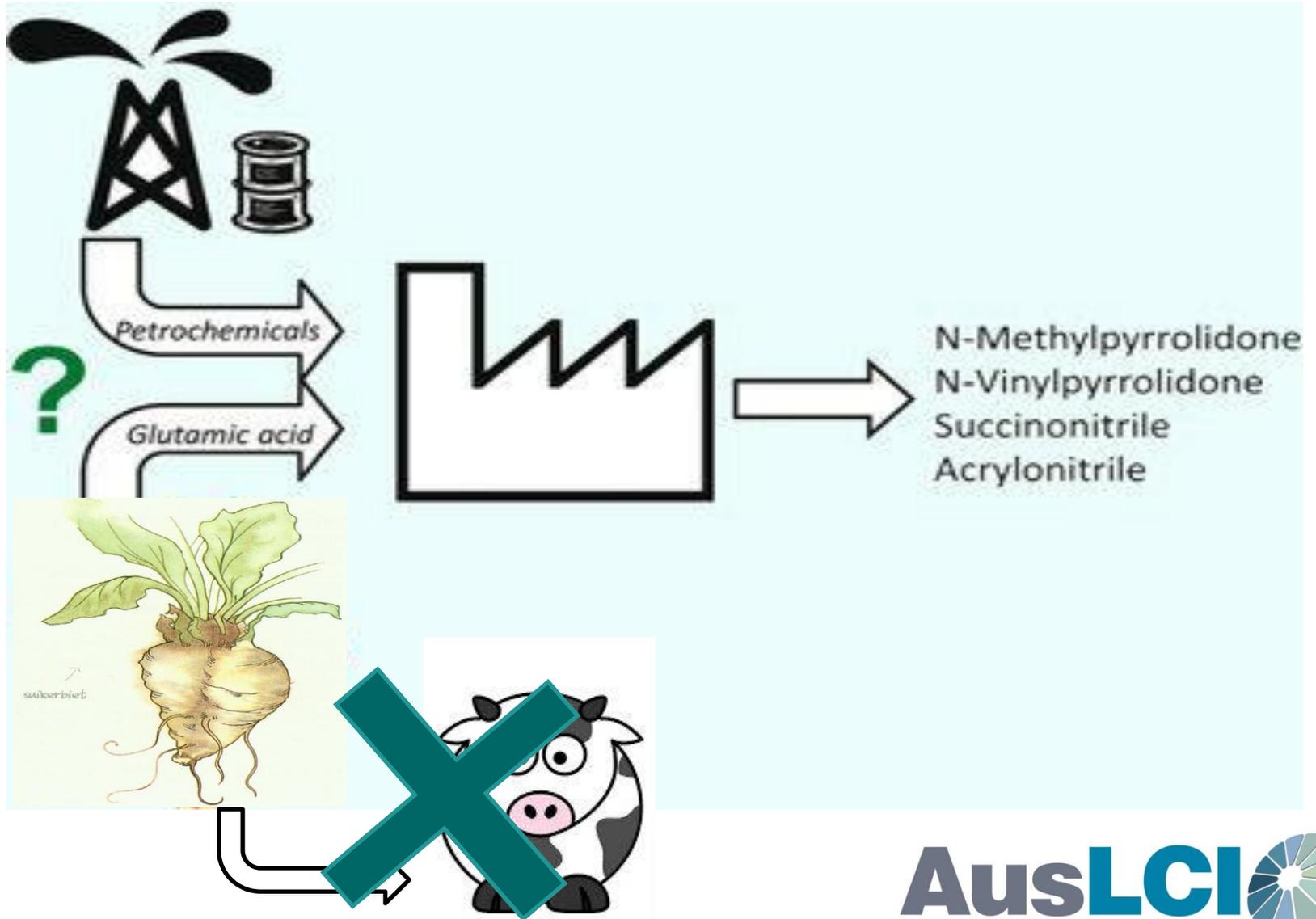
In the EU, plastic carrier bags are considered as packaging under Directive 94/62/EC). However, there is no EU legislation or policy *specifically* targeting plastic carrier bags

The measures taken by individual Member States to tackle the unsustainable consumption of plastic bags lack coherence in terms of the objectives pursued (e.g. favouring alternative bags that are not necessarily more environmental friendly from a life-cycle perspective). This and other considerations explain the sense of urgency to address the issue at the European level; this was reflected both in the political discussions at the Environment Council and the

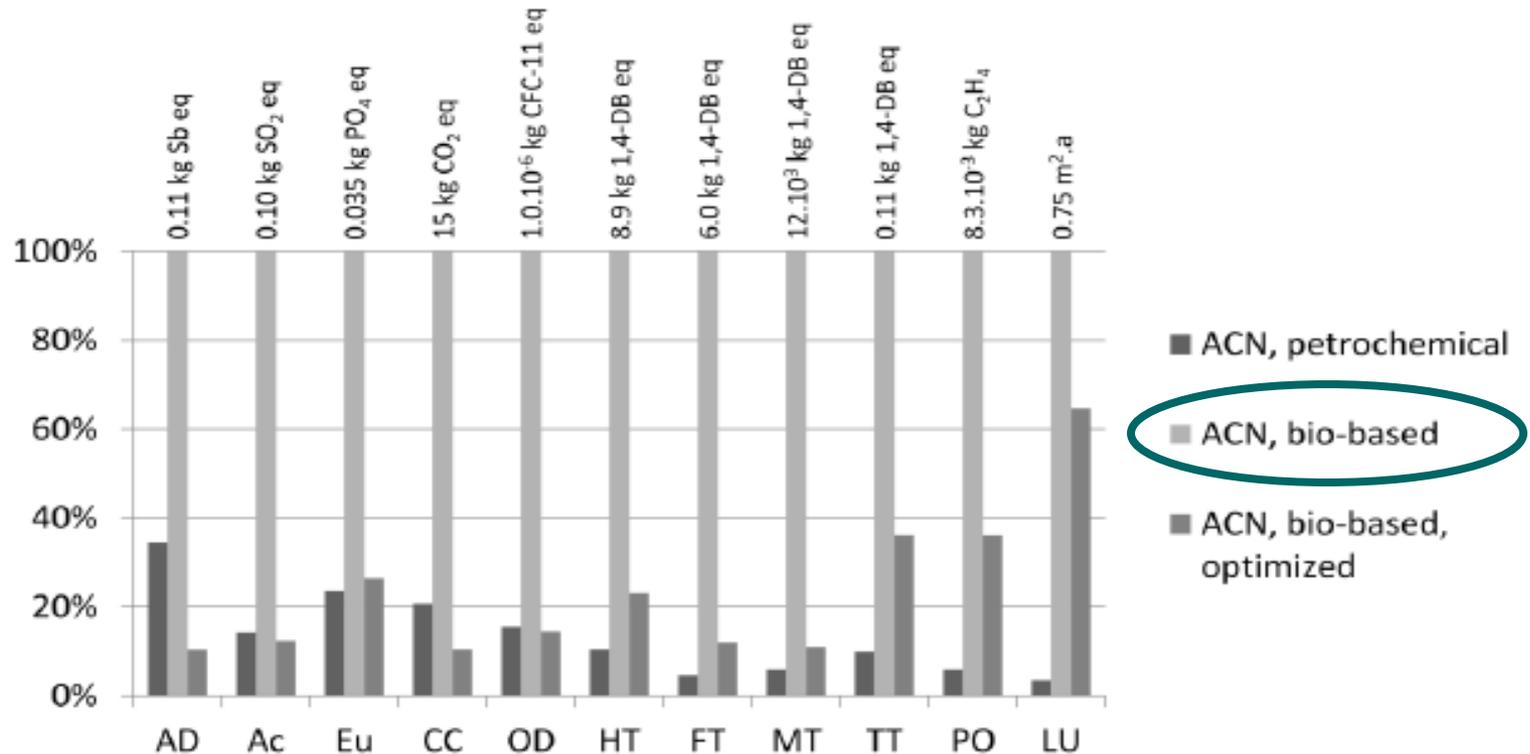
Bio-based LCA : Case II

- Chemicals from biobased glutamic acid (WUR 2011) : amino acids instead of carbohydrates
- From protein “residue” of biofuel production, current application primarily feed → look for higher added-value options

Bio-based LCA : Case II

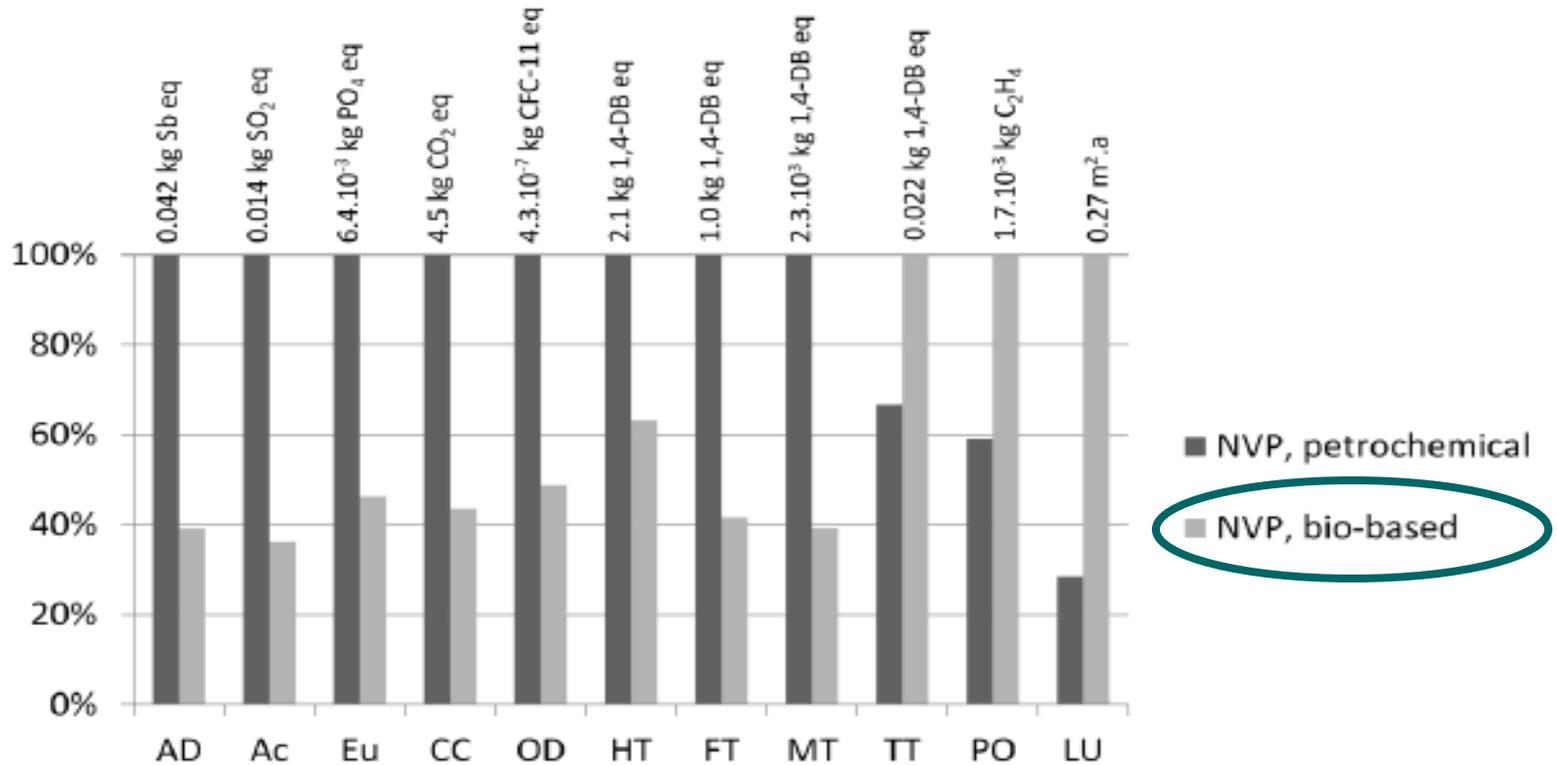


Bio-based LCA : Case II



Acrylonitrile : ingredient of plastics like ABS / SAN / PA
Current bio-based production higher impacts in all categories
Optimized bio-based production comparable to fossil ?

Bio-based LCA : Case II



N-vinyl pyrrolidone: glues / solvents / co-polymer
Current bio-based production lower impacts in most categories

Bio-based LCA : Case III

K. Kimura et al.: Bio-Based Polymers

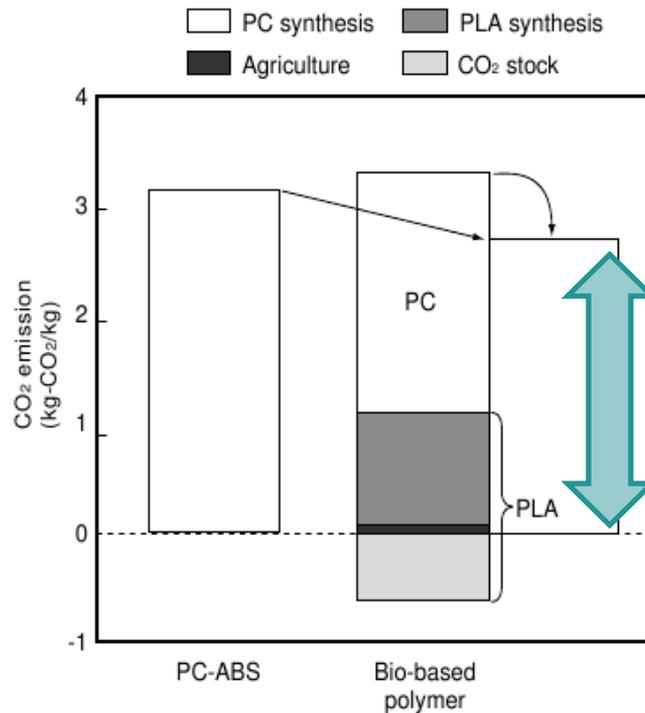


Figure 7
Comparing CO₂ emissions from bio-based polymer production with CO₂ emissions from PC-ABS production.

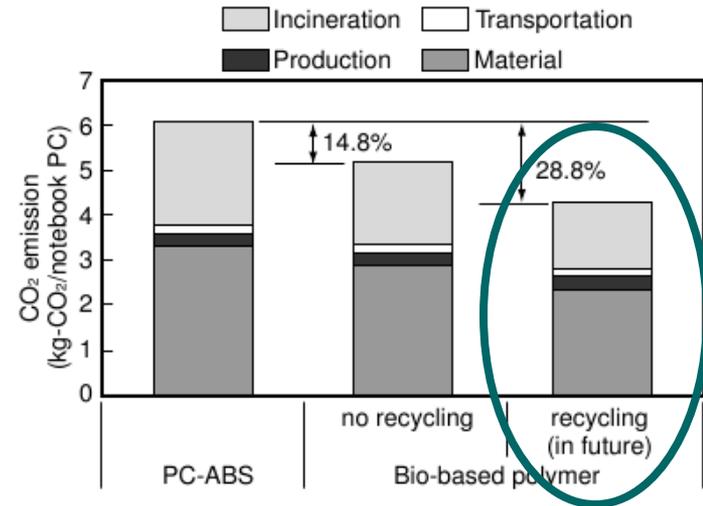


Figure 8
Comparing CO₂ emission from the bio-based polymer and plastic from non-renewable sources.

This has actually been implemented !

Bio-based LCA : Case IV

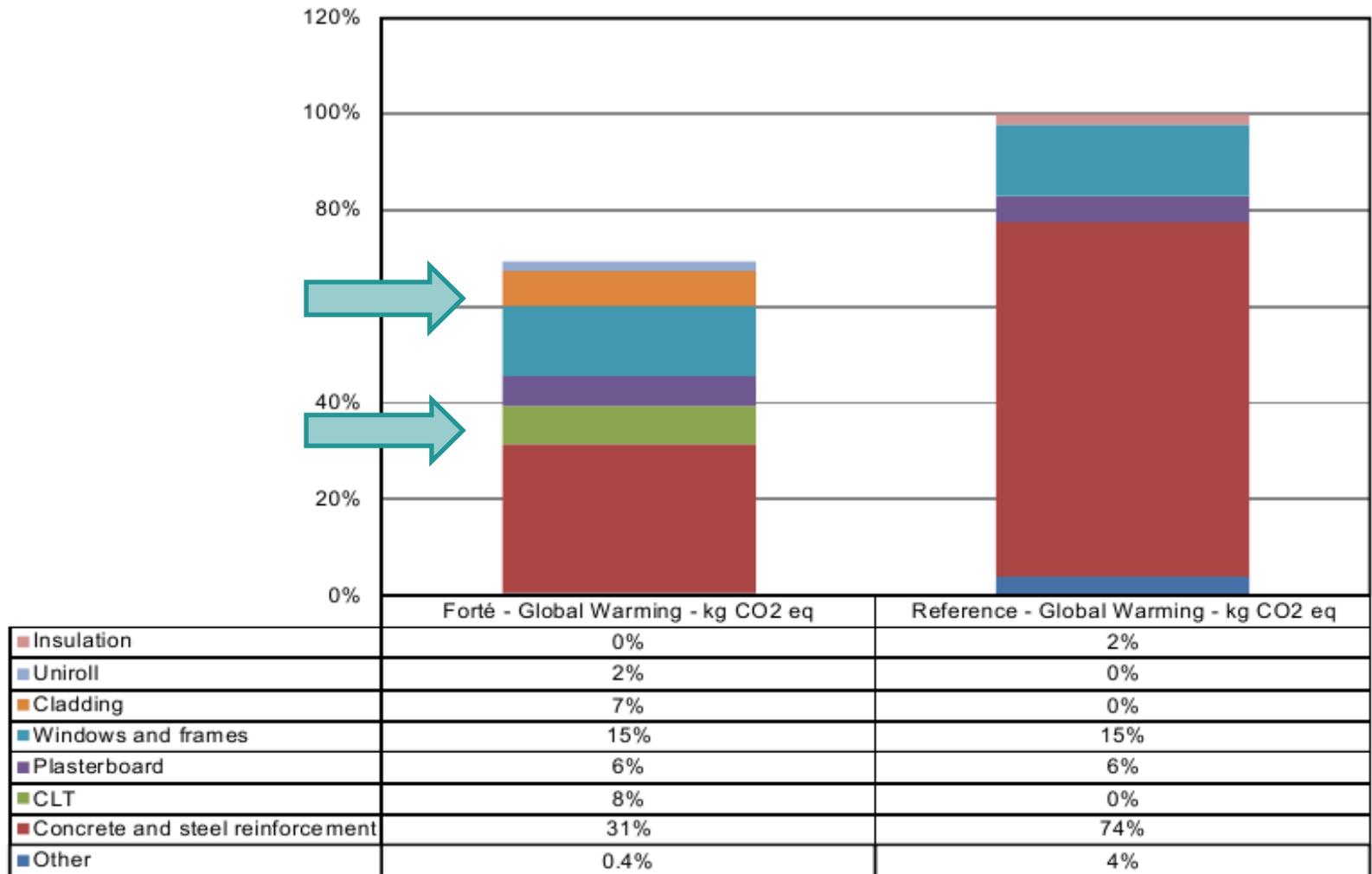


Figure 7-5: Global warming potential during the materials phase. 100%= 931 tonne CO₂ eq sequestration excluded.

Bio-based LCA : Case IV

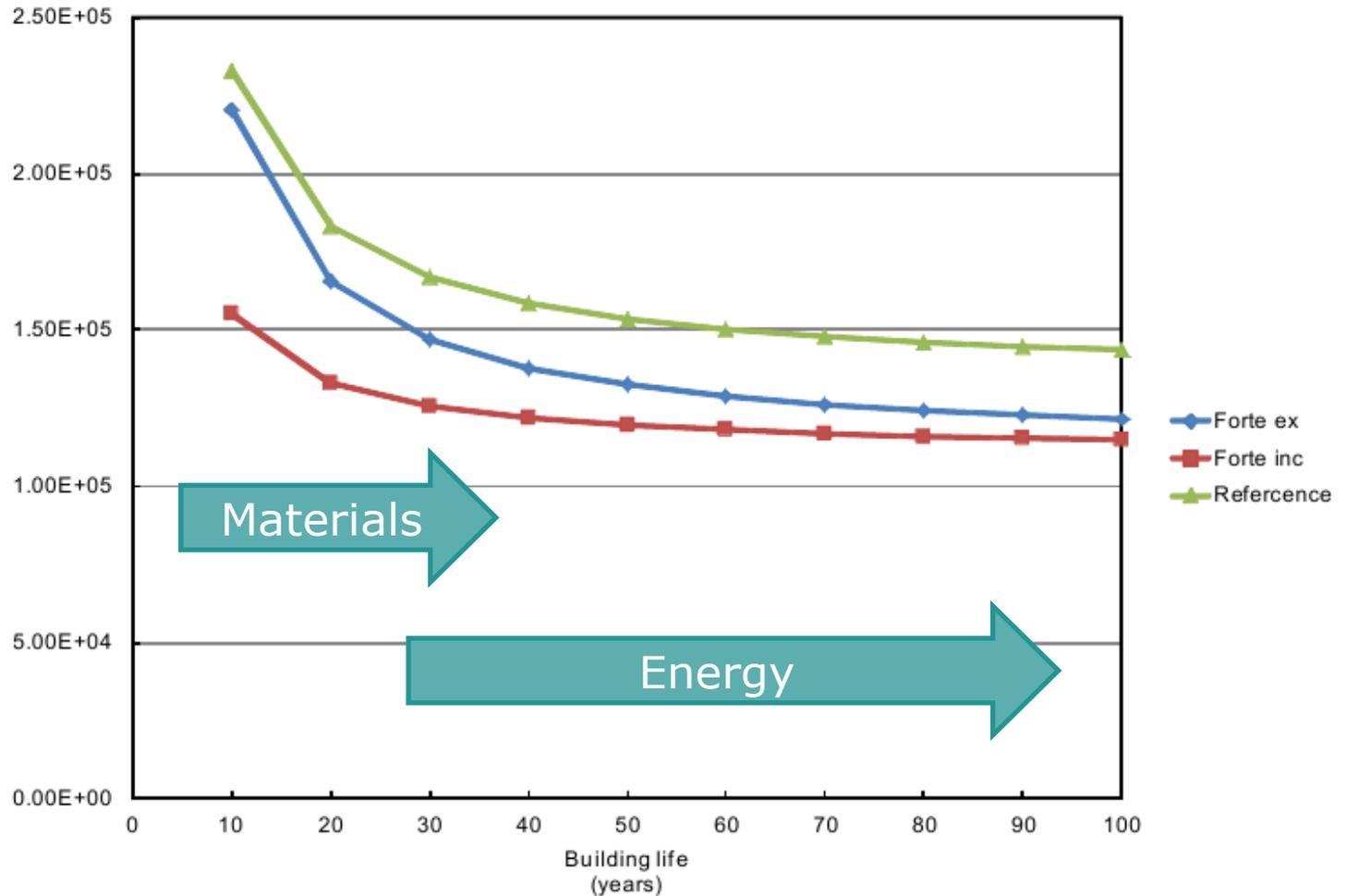


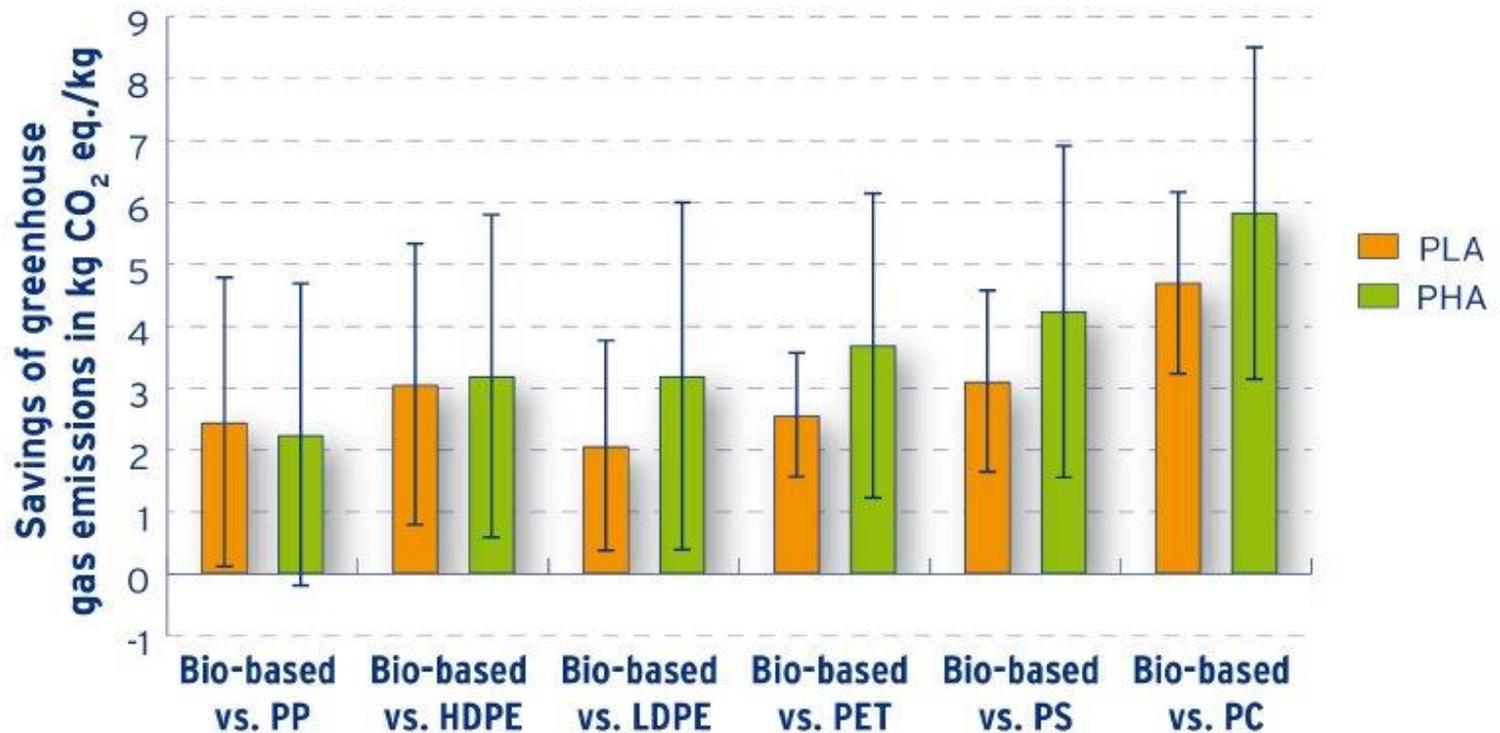
Figure 7-16: Global warming potential, in kg CO₂ equivalent per year, if the life time of the building is varied.

Score...

- Bios vs Fossils : 3-2

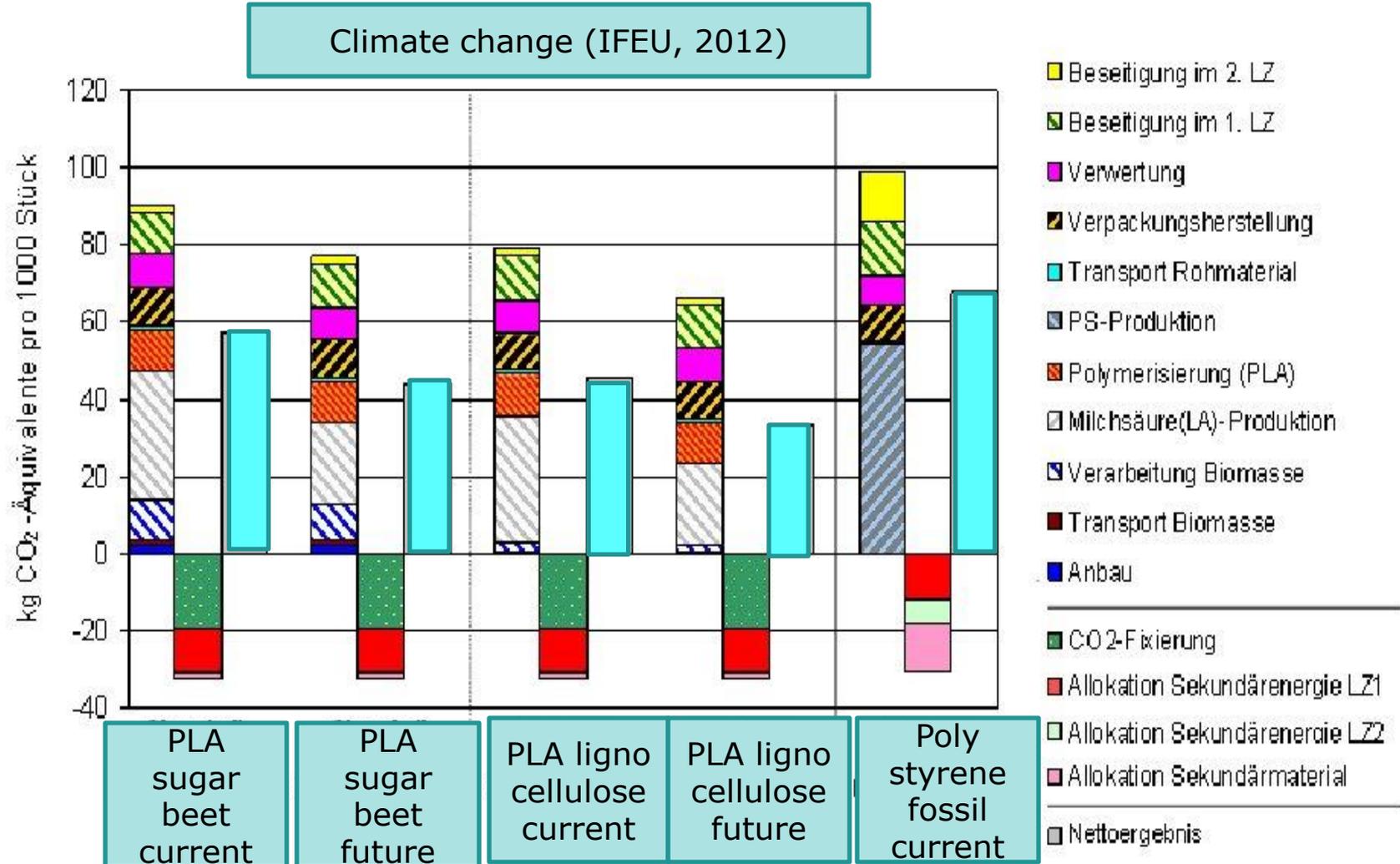
Case V + : bioplastics packaging

Savings of greenhouse gas emissions due to the production of bio-based polymers



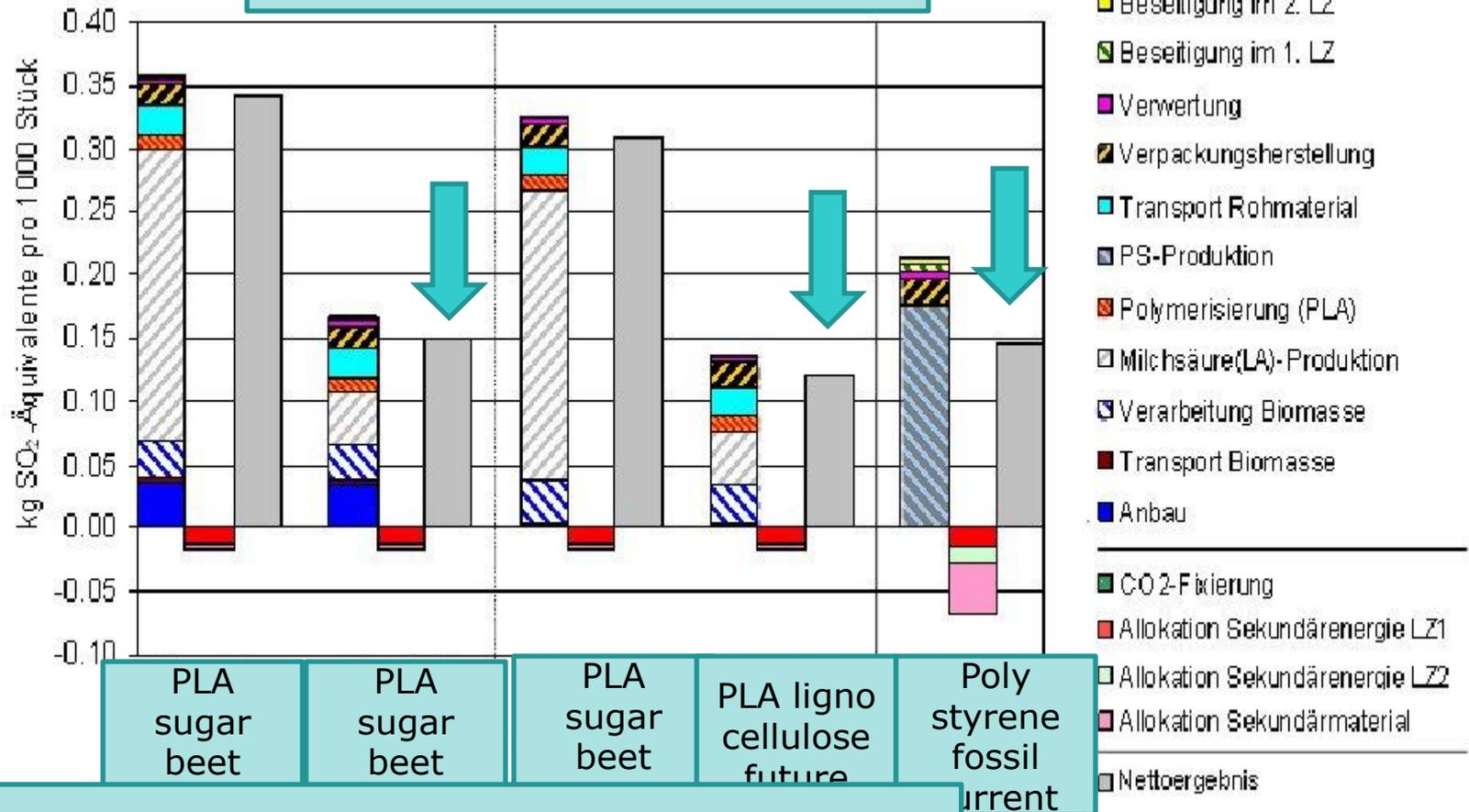
What is the fossil product that is replaced?

Case V + : bioplastics packaging



Case V + : bioplastics packaging

Acidification potential (IFEU, 2012)



What is input material and technology ?

Conclusions

- “Change dependency on fossil fuels without costing the earth”
- Innovative products often not yet optimized so try and assess future performance
- LCA essential instrument to get the full environmental picture
- All case studies used existing LCI data