INSTITUT FÜR ENERGIE- UND UMWELTFORSCHUNG HEIDELBERG

Green light for bio-based products?

Selected examples and lessons learnt from LCAs

Nils Rettenmaier

Bio4Products webinar series #4 “How sustainable is ‘bio-based’ anyway?”, 7 April 2020

Who we are – What we do

- ifeu – Institute for Energy and Environmental Research Heidelberg
- **Independent** scientific research institute since 1978
- Organised as a private **non profit** company
- Currently about **80 employees**

Renewable Resources **Environmental Impact Assessment**

Life Cycle Assessment **Waste Management** **Transport**

Environmental Education **Energy**

Who we are – What we do

Biomass and food: core topics

- **Research / consulting on environmental aspects of**
  - transport biofuels
  - biomass-based electricity and heat
  - biorefinery systems
  - bio-based materials
  - agricultural goods and food
  - cultivation systems (conventional agriculture, organic farming, etc.)
- **Biomass potentials and scenario development**
- **Technologies / technology comparisons**
- **Integrated life cycle sustainability assessment**
  (environment + economy + society + policy + …)










ifeu and LCA: 25+ years of experience

F + E-Vorhaben des Umweltbundesamtes
Nr. 104 08 508/02

Endbericht

Energie- und CO_2-Bilanz von Rapsöl und Rapsölester im Vergleich zu Dieselkraftstoff

ifeu – Institut für Energie- und Umweltforschung Heidelberg
Fachbereich „Verkehr und Umwelt“

Dezember 1991

First full life cycle assessment on biodiesel in Europe

1991

ifeu and LCA: All types of biomass

➔ **Wood, fibre crops, energy crops, food crops, algae, …**

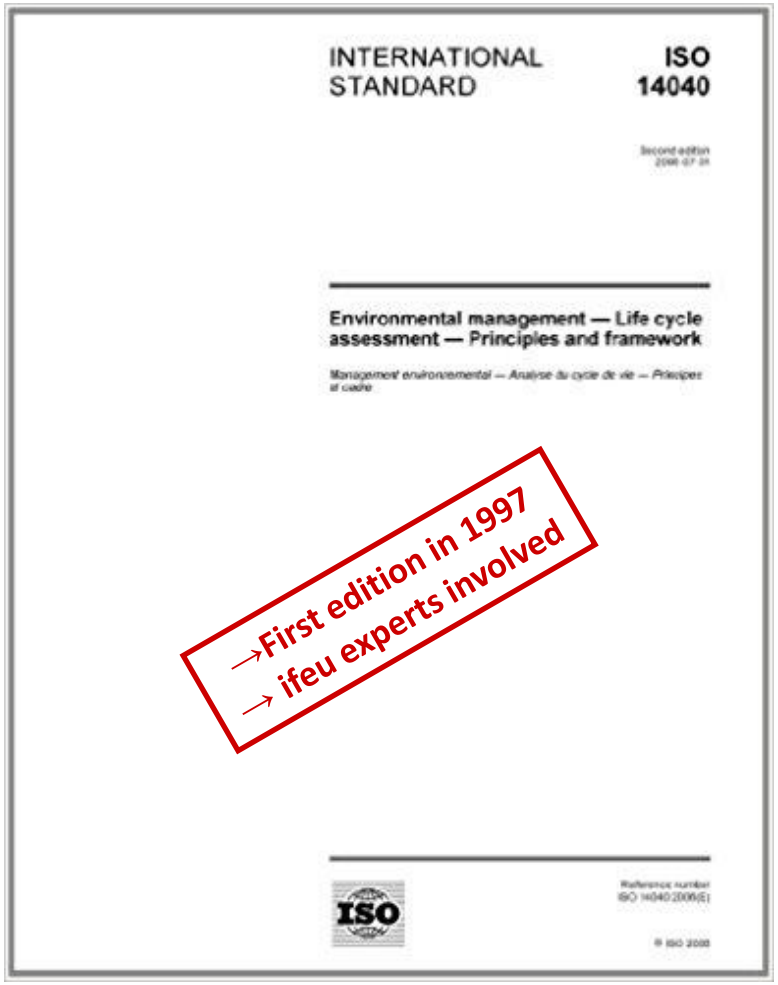
Selected current projects on bio-based products

Project	Project details	Bio-based products
Magic	H2020 project **MAGIC** (GA number 727698)	Biotumen, oleochemicals, insulation material, adhesives
Nano TextSurf	H2020 project **NanoTextSurf** (GA number)	Membranes, protective textiles, friction pads, abrasive materials
UNRAVEL	BBI-JU project **UNRAVEL** (GA number 792004)	bio-polymers, insulation foams (polyurethane), bitumen
SinFonia	H2020 project **SinFonia** (GA number 814418)	Fluoropolymers
vamos creating value from waste	BBI-JU project **VAMOS** (GA number 837771)	Bioresin, purified lactic acid (LA), PLA/fibre composite materials
…	…	…

Outline

1. LCA methodology in a nutshell
2. Selected examples of LCAs for bio-based products
3. Lessons learnt and conclusions

LCA overview: ISO 14040 & 14044



→First edition in 1997
→ ifeu experts involved

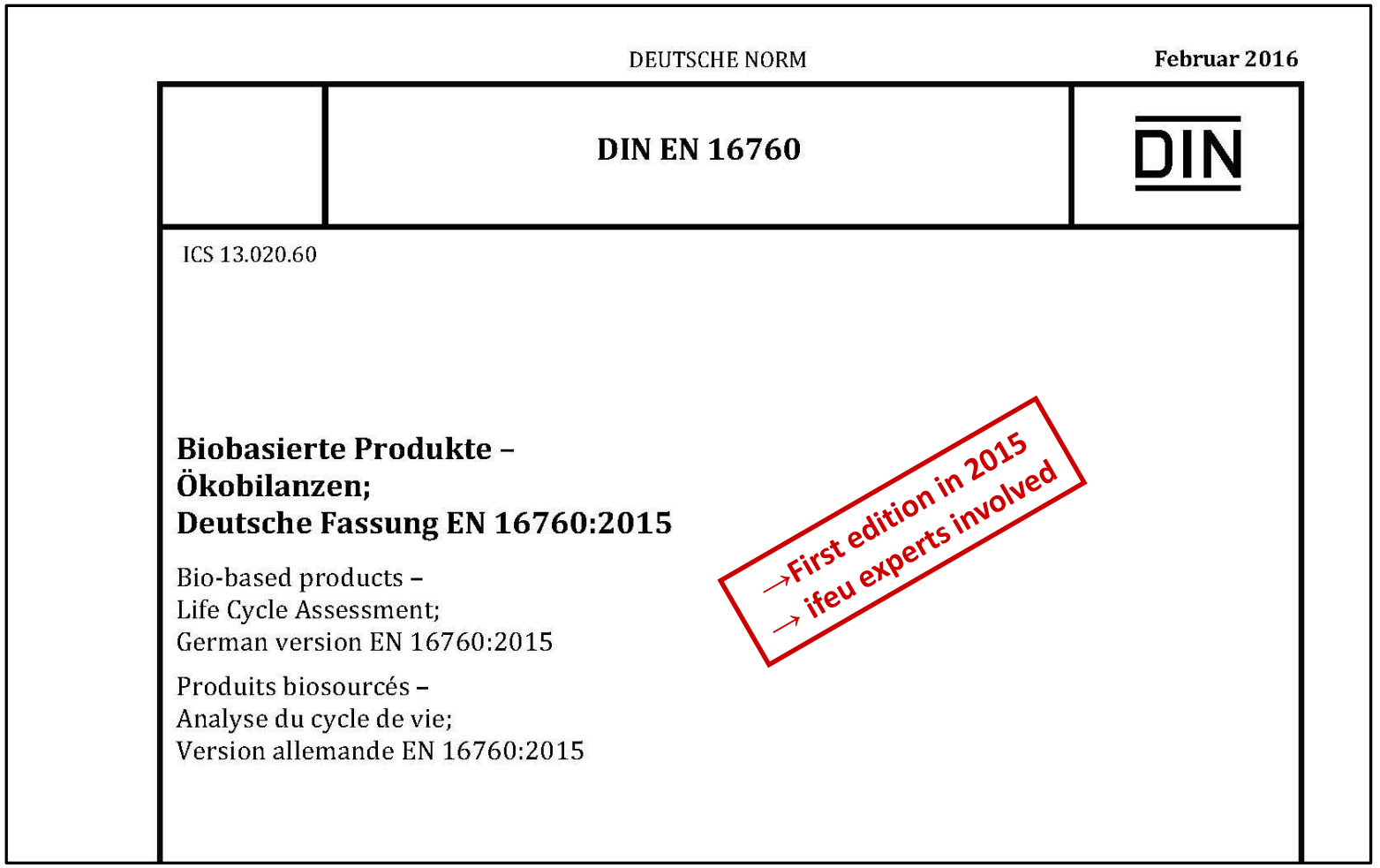
LCA overview

LCA addresses

- the environmental aspects and **potential environmental impacts** (e.g. use of resources and the environmental consequences of releases)
- **throughout the life cycle** from raw material acquisition through production, use, end-of-life treatment, recycling and final disposal (i.e. **cradle-to-grave**)
- of a **product** (*any* good or service).

Source: ISO 14040

LCA overview: EN 16760 for bio-based products



DEUTSCHE NORM Februar 2016

DIN EN 16760

DIN

ICS 13.020.60

Biobasierte Produkte –
Ökobilanzen;
Deutsche Fassung EN 16760:2015

Bio-based products –
Life Cycle Assessment;
German version EN 16760:2015

Produits biosourcés –
Analyse du cycle de vie;
Version allemande EN 16760:2015

→First edition in 2015
→ ifeu experts involved

Selected examples

Methodology

- *Screening* LCAs based on ISO 14040 and 14044
- 9 midpoint impact categories (LCIA: CML)
- Comparative assessment: bio vs. fossil
- Normalisation: EU inhabitant equivalents

Duration
07/2010 – 03/2013

Commissioned by
German Federal Environment Agency (UBA)

Selected case studies

1,3-propanediol	Wood fibre insulation
Polylactide (PLA)	Hemp fibre composite
Packaging paper	Cascading use of wood

Selected examples

COSMOS
ADDING VALUE TO CAMELINA AND CRAMBE OIL

Duration
03/2015 – 08/2019

Funded by
European Union's
H2020 programme

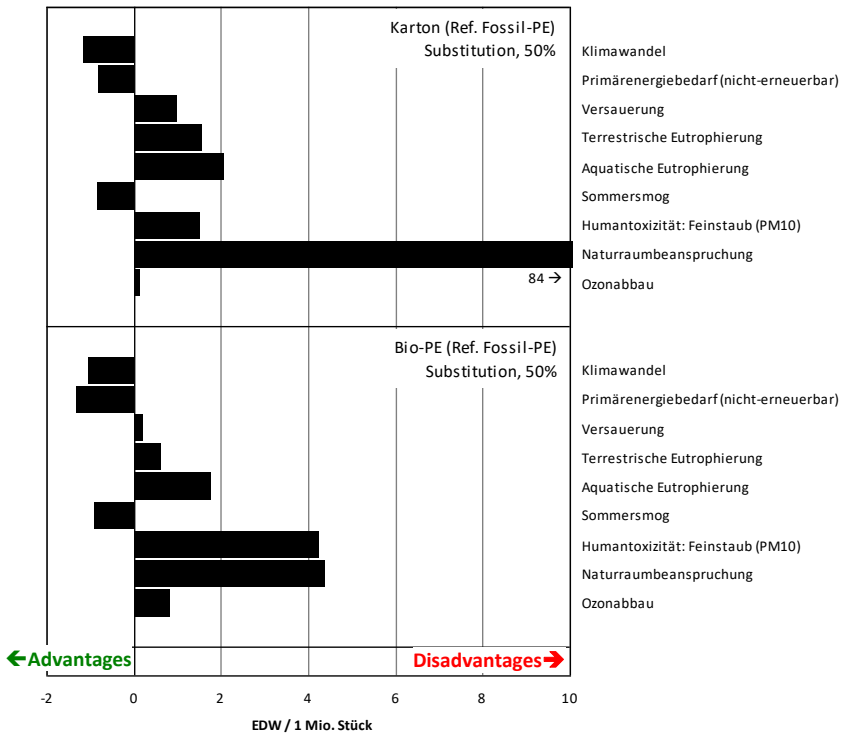
Methodology

- *Screening* LCAs based on ISO 14040 and 14044
- 10 midpoint impact categories (LCIA: ReCiPe)
  - Phosphate footprint + Land use footprint by ifeu
- Consequential modelling
- Comparative assessment: bio vs. (bio+fossil)
- Normalisation: EU inhabitant equivalents

Investigated products

- Speciality oleochemicals from Camelina and Crambe (substituting tropical oil crops)

Example: Packaging paper

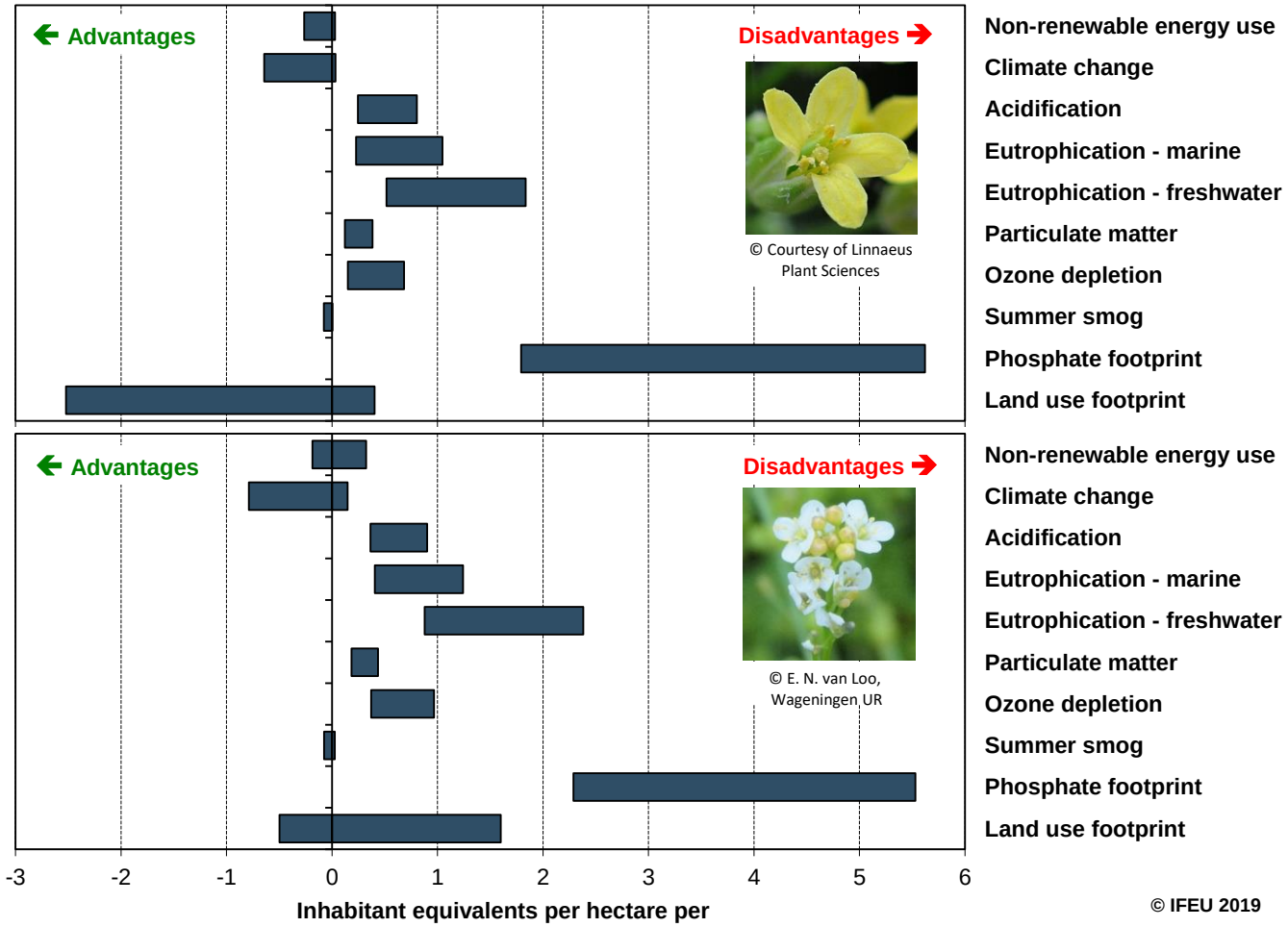


Environmental impacts

- All selected bio-based products show both environmental advantages and disadvantages compared to their conventional equivalents.
- This pattern is already known from many life cycle assessments for bioenergy carriers / biofuels.
- For a final result of the comparative life cycle assessment, a further evaluation would be necessary.

Source: Rettenmaier , N. et al. (2014): Lebenszyklusanalysen für ausgewählte bio-basierte Produkte. Available at: https://bit.ly/3e3eMkD

Example: Speciality oleochemicals



Source: Reinhardt, G., Rettenmaier, N., Wagner, T. (2019): Final report on environmental assessment of the COSMOS value chains. Available at: http://www.ifeu.de/cosmos

Example: 6 case studies

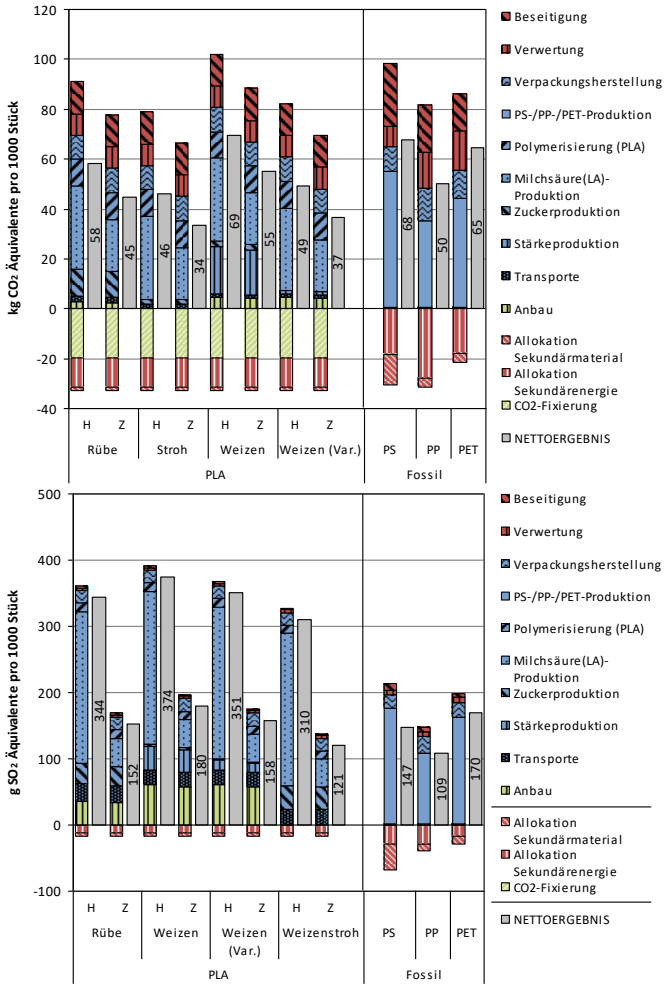
Life cycle comparison	Functional unit
1,3-propanediol (PDO) from sugar beet, wheat & poplar vs. fossil PDO	1000 kg 1,3-propanediol (PDO)
Polylactide (PLA) vs. PS, PP and PET	1000 clamshells for 500 ml goods
Carton vs. foil packaging from petro-LDPE / bio-PE	Packaging for 500 g spaghetti
Wood fibre insulation vs. rock wool or polystyrene	1 m² insulation surface with a specific heat transfer coefficient
Hemp fibre composite vs. glass fibre or ABS (acrylo-nitrile butadiene styrene)	1 pc. Car door interior lining
Cascading use of wood products instead of con-vent. reference products	1 m roof beam, 1 m² shelf space, 1 kWh electricity, 1 MJ heat

Methodological issues

- It is impossible to determine one common functional unit for all bio-based products
- However, comparisons between different products are possible after conversion to a uniform reference unit (e.g. area)
- For each LCA, specific settings are needed regarding the end-of-life stage (more complex than for bioenergy carriers).

Source: Rettenmaier , N. et al. (2014): Lebenszyklusanalysen für ausgewählte bio-basierte Produkte. Available at: https://bit.ly/3e3eMkD

Example: PLA clamshells

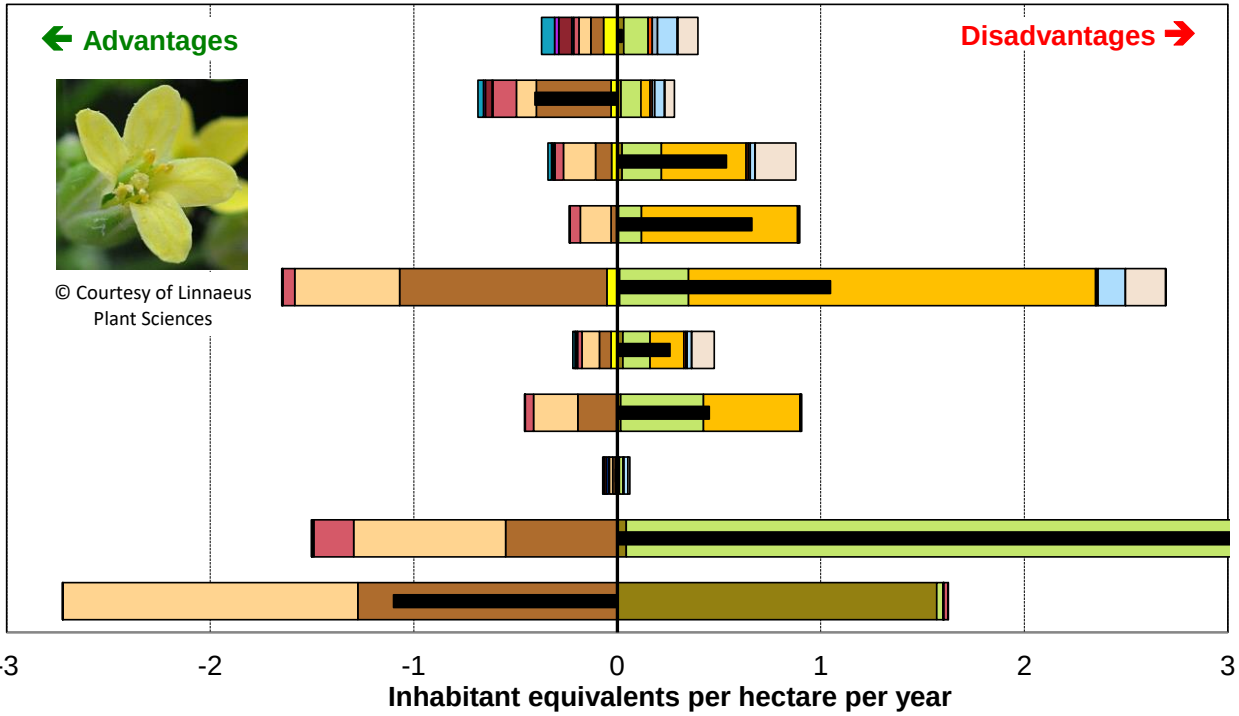


Result-determining processes

- Depending on the respective bio-based product and the impact category considered:
  - Production of the biomass
  - Expenses for the envisaged bio-based product
  - Environmental impacts associated with the conventional reference product
  - Use phase and the type of co-product use
  - End-of-life (recovery and/or disposal) of the bio-based products

Source: Rettenmaier , N. et al. (2014): Lebenszyklusanalysen für ausgewählte bio-basierte Produkte. Available at: https://bit.ly/3e3eMkD

Example: Speciality oleochemicals



Source: Reinhardt, G., Rettenmaier, N., Wagner, T. (2019): Final report on environmental assessment of the COSMOS value chains. Available at: http://www.ifeu.de/cosmos

Lessons learnt from LCAs for bio-based products

Suitability of the chosen method

- **Life cycle assessments (LCA) are a suitable and recognised instrument** for quantifying the environmental impacts of bio-based products.
  - Carbon footprint alone is not sufficient (→address all environmental impacts!)
  - Local environmental impacts to be addressed (e.g. by supplementary LC-EIA)
- However, a **transfer of the results** for the products investigated here **to other bio-based products is not permitted**, as the results may vary considerably in individual cases.
- **LCAs for bio-based products can hardly be standardised** (in contrast to LCAs for bioenergy), as the use and end-of-life phases can be very different.
- For this reason, **curtailed assessments of the bio-based life cycle** (e.g. cradle-to-gate balances) **are strongly discouraged**.

Concluding remarks

Overall assessment and recommendations for decision makers

- **Bio-based products are not environmentally friendly (or sustainable)** ***per se***, just because biomass is a renewable resource.
  - In terms of environmental impacts, they are on a par with bioenergy carriers.
- From a **security of supply** perspective, it would make sense to steer biomass towards industrial use in the future and to emphasise the **role of biomass as a renewable carbon source**.
- With the expansion of industrial use of biomass, an **increase in the** already prevailing **competition for land and biomass use** (including indirect effects) is to be expected.
  - Mandatory sustainability criteria for biomass irrespective of its later use (bioenergy, bio-based products, food/feed) are needed.

INSTITUT FÜR ENERGIE- UND UMWELTFORSCHUNG HEIDELBERG

Thank you very much for your attention!

Nils Rettenmaier
nils.rettenmaier@ifeu.de

Downloads
www.ifeu.de