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UNA Universität Augsburg University

Life Cycle Sustainability Assessment of Substituting Fossil-based with Biogenic Products A German Case Study

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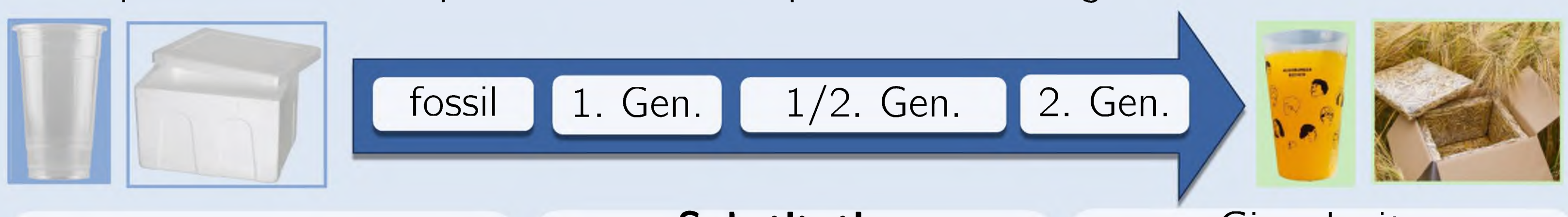
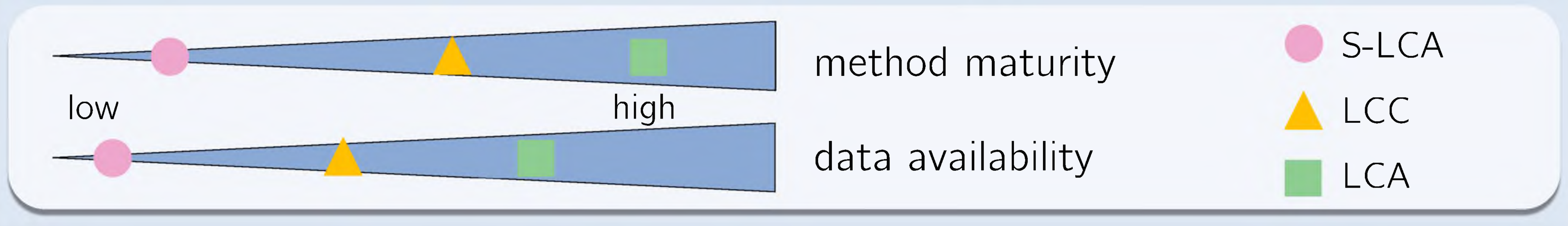
MOTIVATION & AGENDA

In 2022 3.2 million tons of unused **bioeconomic potential** existed in Bavaria, Germany [1]. This potential could replace conventional plastics with biogenic materials.



Avoidance	**Substitution**	Circularity
plastics & plastic waste	conventional plastics with bio-based alternatives	bio-based & conventional plastics

State of the Art [2]



Research Questions

- Are biogenic products more sustainable than conventional ones?
- How do characteristics (e.g., recycling quota, electricity, ...) affect sustainability?

CASE STUDY

Data Collection

Primary Data	Secondary Data
reGIOcycle Project	Literature & ecoinvent v.3.9.1 & SHDB

Impact Assessment

Environmental Footprint 3.1	External Costs (EC, 2020)	Social Hotspots Database (SHDB)

Research Aim & Approach

Design

Life Cycle Sustainability Assessment: LCA & LCC & S-LCA

RoW – Raw Materials → Germany – Production → Region of Augsburg, Bavaria – Use → End-of-Life

Cradle-to-Grave

Characteristics

Nº	Product system		Functional Unit (FU)
1	drinking cup		Provide a 400 ml cup for serving a certain number of cold drinks [in the basic scenario: 15]
2	insulation box		Keep goods below 4°C for 24 h using a 22-liter insulation box

Nº	Biomass Generation	Fossil	1. Generation	1/2. Generation	2. Generation
1		PP	PLA	PLA + Cellulose	Bio-PE
2		EPS	Hemp	Cardboard	Straw

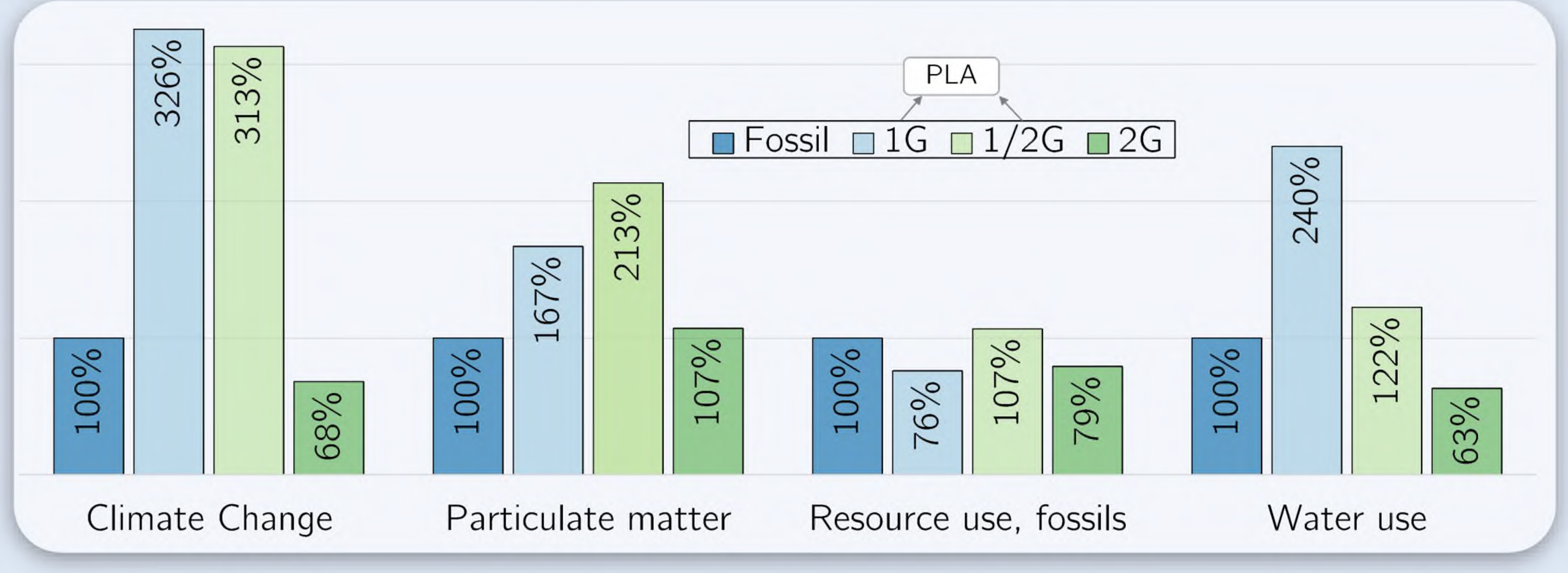
Dimension	Characteristics						
Product System	Drinking CUP			Insulation BOX			
Raw Materials (biomass generation)	Fossil	1G		1/2G		2G	
Raw Materials (allocation)	100%	Economic, based on ecoinvent		0%			
Transportation from (RM to Prod.)	Globally	Thailand	Brazil	Europe	Germany (often CH)	Augsburg Region	
Production (electricity)	German electricity mix (2022)			Only renewable energy			
Transportation (within Germany)	German lorry mix (2022)			Only EURO 6 lorry			
Use (# of usages)	1	10	15	20	100	300	500
EoL (recycling quota)	0%	43%	50%	78%	80%	90%	

[1] Wietschel, L., Thorenz, A., & Tuma, A.. (2021). Rohstoffdatenbank Landwirtschaftlicher Reststoffe für Bayern und Baden-Württemberg [Data set]. Zenodo. https://doi.org/10.5281/zenodo.5027440

[2] Valdivia, S., Backes, J.G., Traverso, M. et al. Principles for the application of life cycle sustainability assessment. Int J Life Cycle Assess 26, 1900–1905 (2021). https://doi.org/10.1007/s11367-021-01958-2

RESULTS

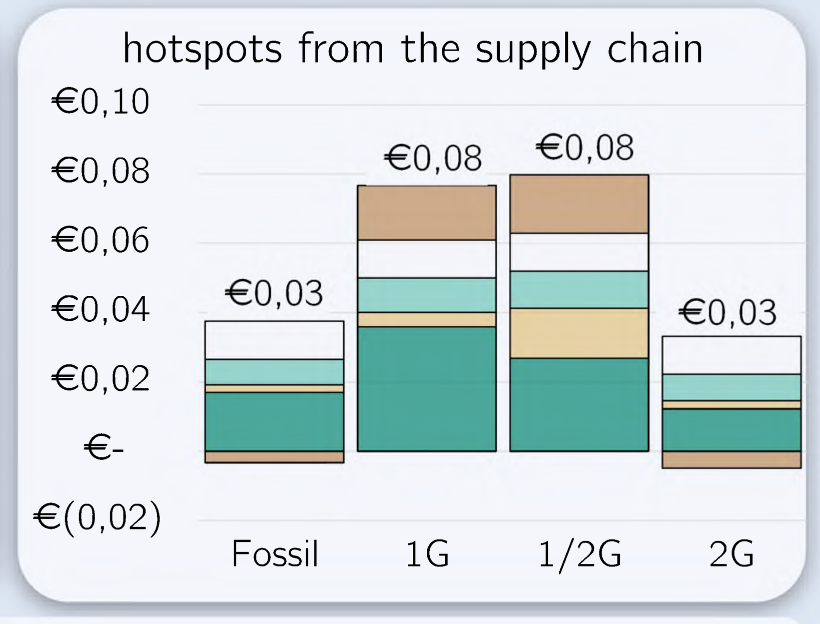
LCA – drinking cup



- fossil products set to 100%
- nonexistent PLA recycling pathways → high impacts
- bio-PE drop-in solution

LCC – drinking cup

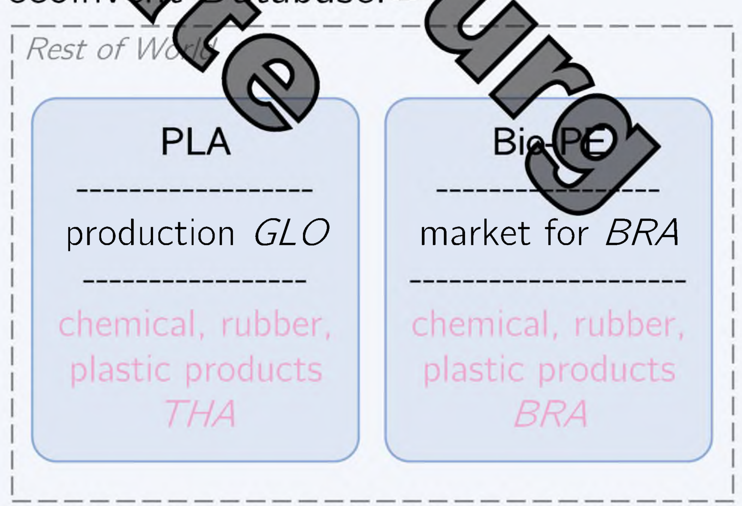
Raw Materials → Transport → Production → Use → EoL



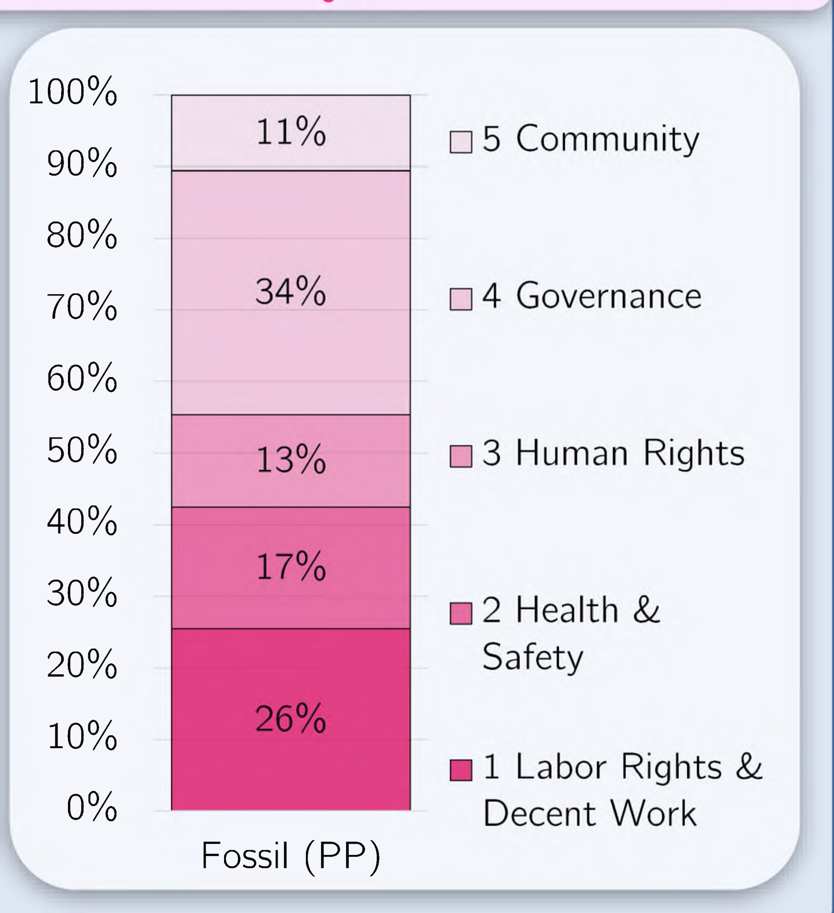
- Calculating external costs, similar to the true cost accounting approach
- End-of-Life can be beneficial or "expensive"

S-LCA – drinking cup

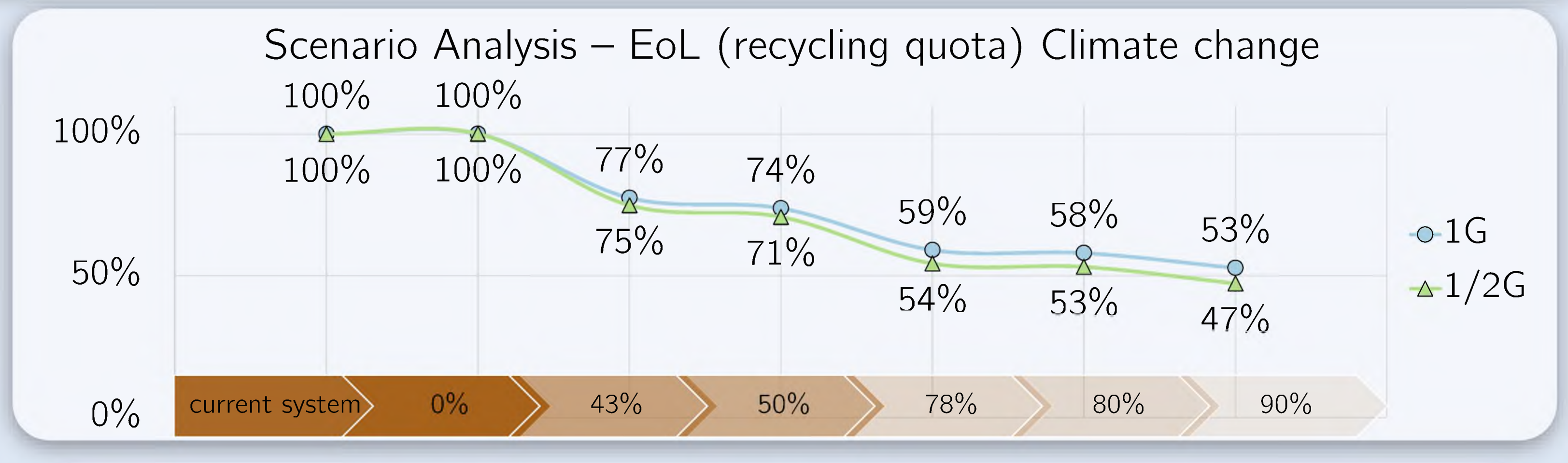
Mapping the 57 sectors for 140 countries and regions to the ecoinvent-Database.



- Fossil PP-Cup→ 4B = corruption (Raw Materials)



CONCLUSIONS



- no clear conclusion on biomass 'generation'
- improving sustainability
  - LCA: recycling quota (recycling instead of incineration of PLA)
  - S-LCA: regional sourcing
- similar trend is observed for the insulation box product system
- availability of primary data highlights the need for further research

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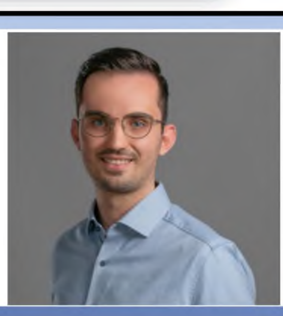

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RESOURCE LAB

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