UFZ HELMHOLTZ Zentrum für Umweltforschung

Key sustainability issues for implementing bioeconomy regions

Alberto Bezama

20.10.2020

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- Bioeconomy and regional challenges
- The life cycle thinking – life cycle management
- Case study of a regional bioeconomy
- Lessons learned

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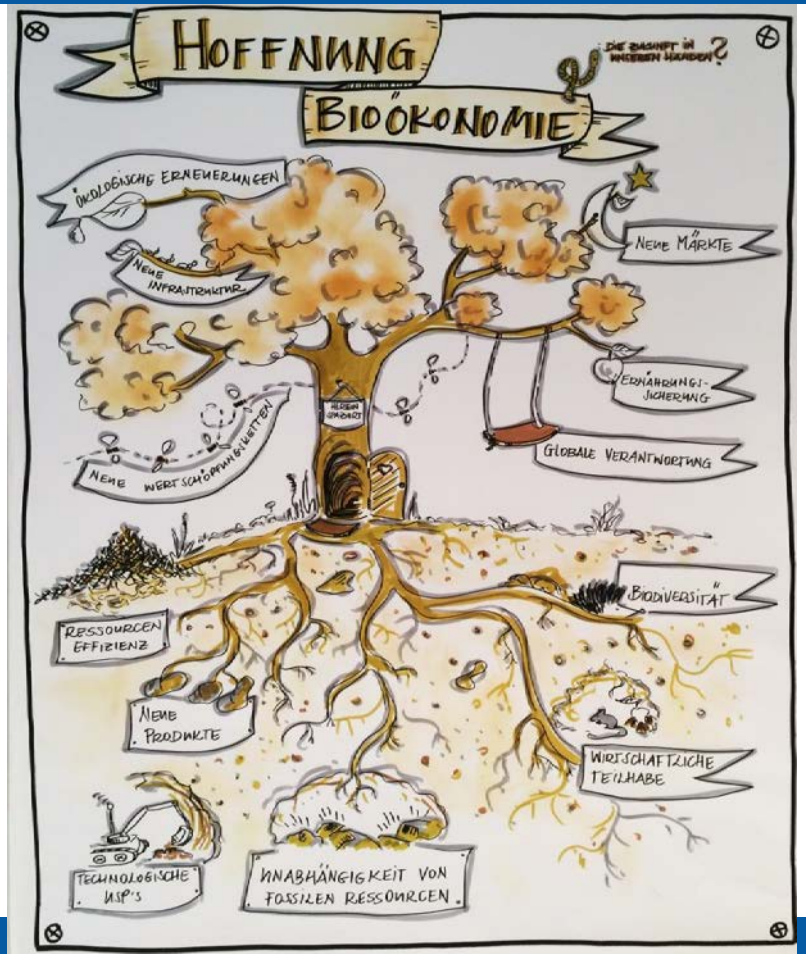
Bioeconomy and regional challenges

The Bioeconomy Challenges...



Systems thinking

Challenges from a regional perspective

sustainability

MDPI

Article

Resources, Collaborators, and Neighbors: The Three-Pronged Challenge in the Implementation of Bioeconomy Regions

Alberto Bezama [1,*], Carlo Ingrao [2], Sinéad O'Keeffe [1] and Daniela Thrän [1,3]

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[2] Faculty of Engineering and Architecture, Kore University of Enna, 94100 Enna, Italy; carlo.ingrao@unikore.it
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Received: 13 November 2019; Accepted: 14 December 2019; Published: 17 December 2019

Challenges from a regional perspective

BIOECONOMY GOALS

sustainabil

MDPI

Article

Alberto Bezama [1,*], Carlo Ingrao [2], Sinead O'Keeffe [1] and Daniela Thrän [1,3]

Sustainable Feedstock Basis	Regional Critical Mass	Public / Social Acceptance
Intensive datasets for biomass availability and regional limitations	Material flow management tools and adequate governance structures	Expansion of social system analysis
Regional and national feedstock strategies	Sustainability Index	Involvement of regional stakeholders
Systems approach for assess-ing the regional landscape	Clusters and Networks as platforms	

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The life cycle thinking – life cycle management

Systems analysis and LCM

Jule_Berlin / Getty Image

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Systems analysis and LCM

Understanding	Analyzing	Implementing
• Resources • Infrastructures • Market conditions • Social aspects	• Modelling • Scenarios • Political framework analysis • Social / consumer behaviours	• Recommendations
Knowledge capital: acquisition/management	**Knowledge generation/ learning**	**Optimization of the framework conditions of the Bioeconomy**

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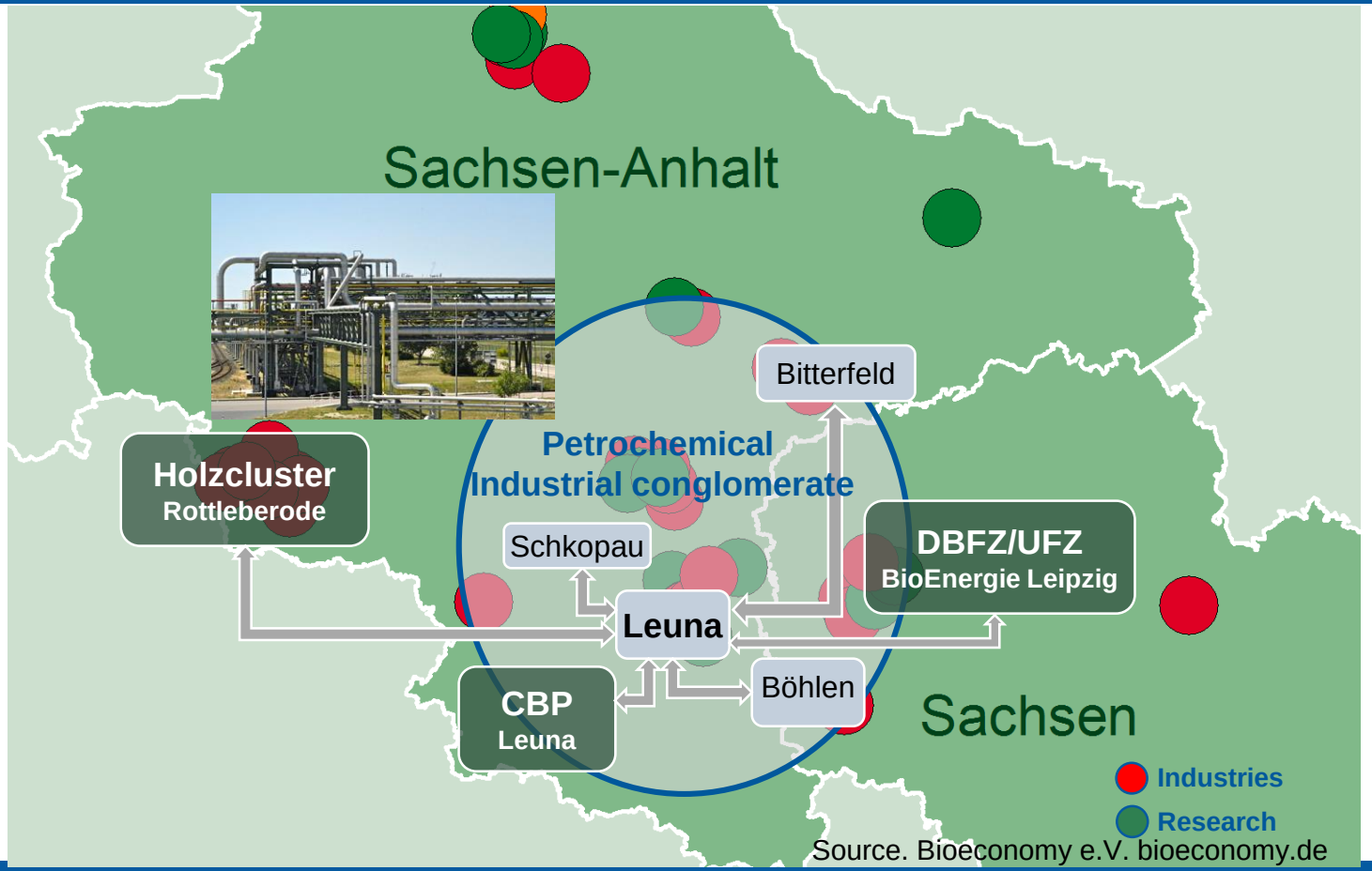
Case study of a regional bioeconomy

The Cluster Bioeconomy e.V.

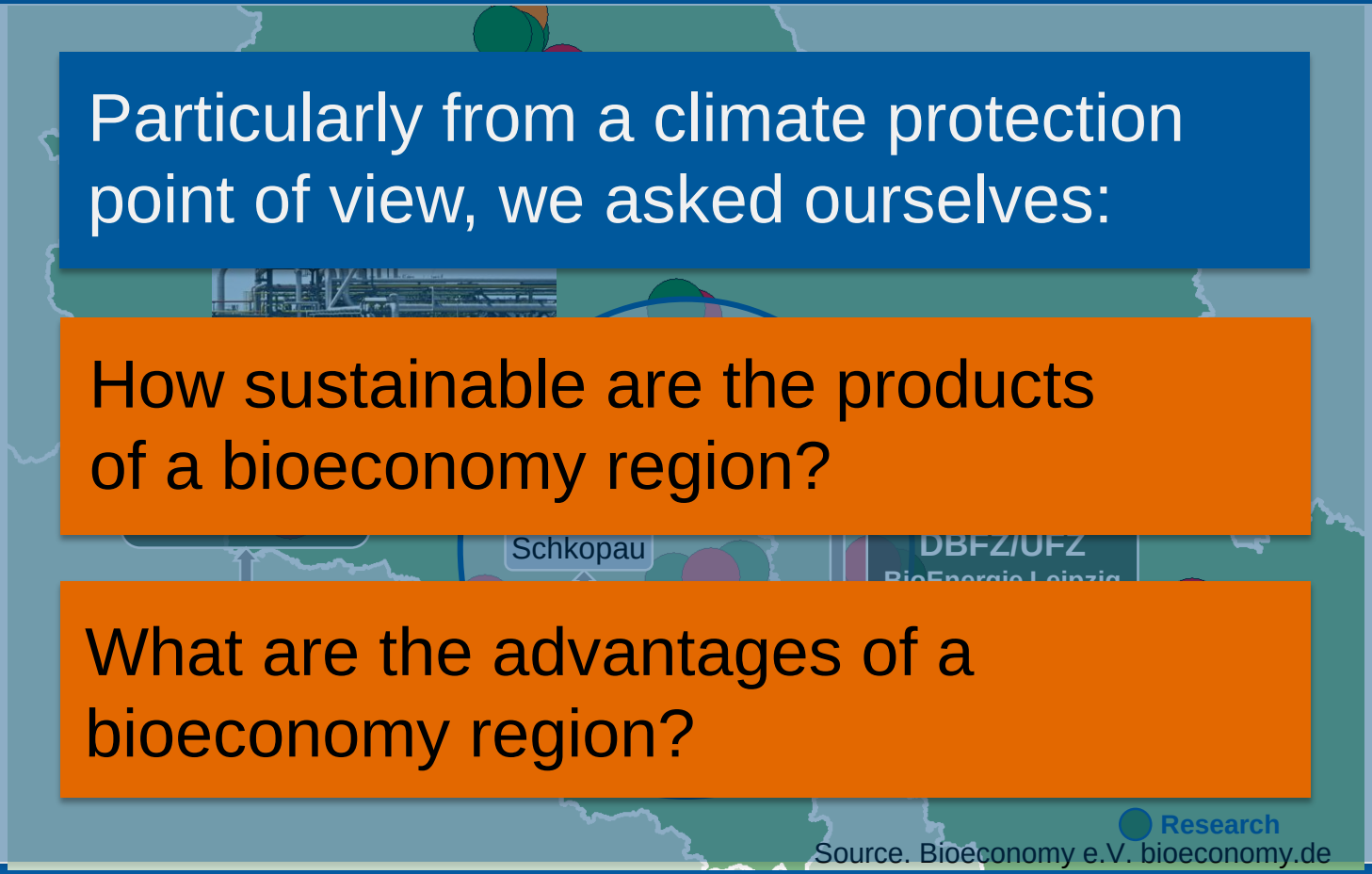


Source. Bioeconomy e.V. bioeconomy.de

Particularly from a climate protection point of view, we asked ourselves:

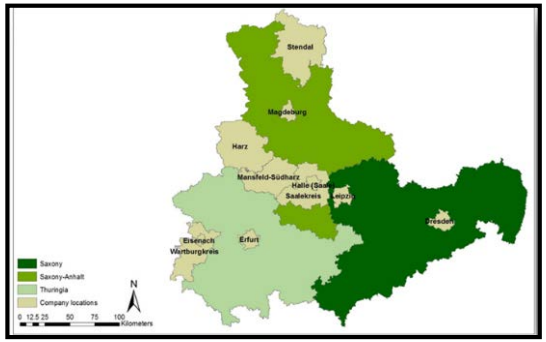
How sustainable are the products of a bioeconomy region?

What are the advantages of a bioeconomy region?

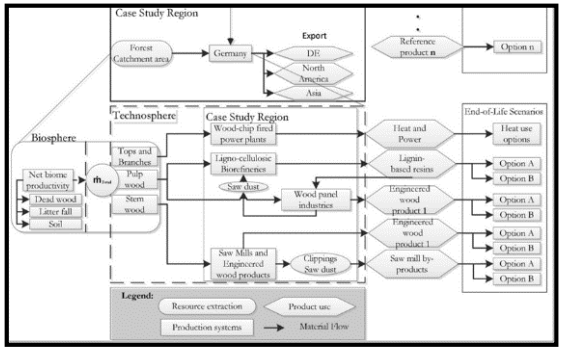


Source. Bioeconomy e.V. bioeconomy.de

How to measure and monitor sustainability of value chains in a bioeconomy Region?



Quelle: Hildebrandt 2018, Promotionsschrift, "Monitoring the sustainability of added-value networks within bioeconomy regions



Quelle: Hildebrandt 2018, Promotionsschrift, "Monitoring the sustainability of added-value networks within bioeconomy regions

How can the overall system efficiency be evaluated ?

How to define the system boundaries ? How do chains and networks differ ?

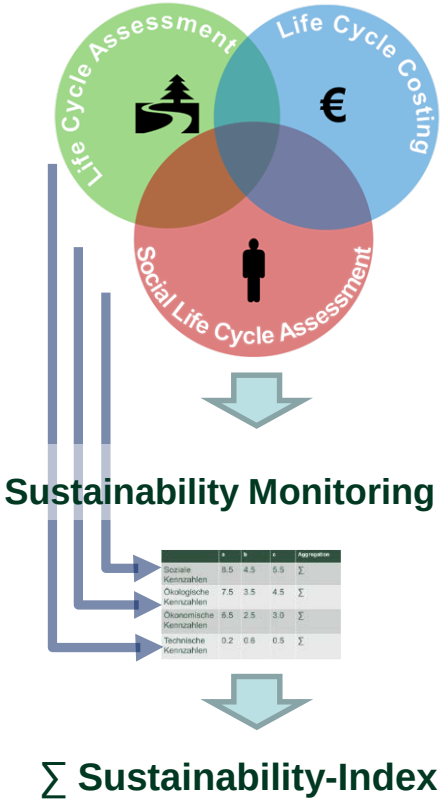
Which approaches to preference-based assessment can be integrated ?

Which transformation coefficients are characteristic for the investigated processes ?

Which socio-economic indicators can and should be collected ?

What emission parameters can and should be collected ?

Goals



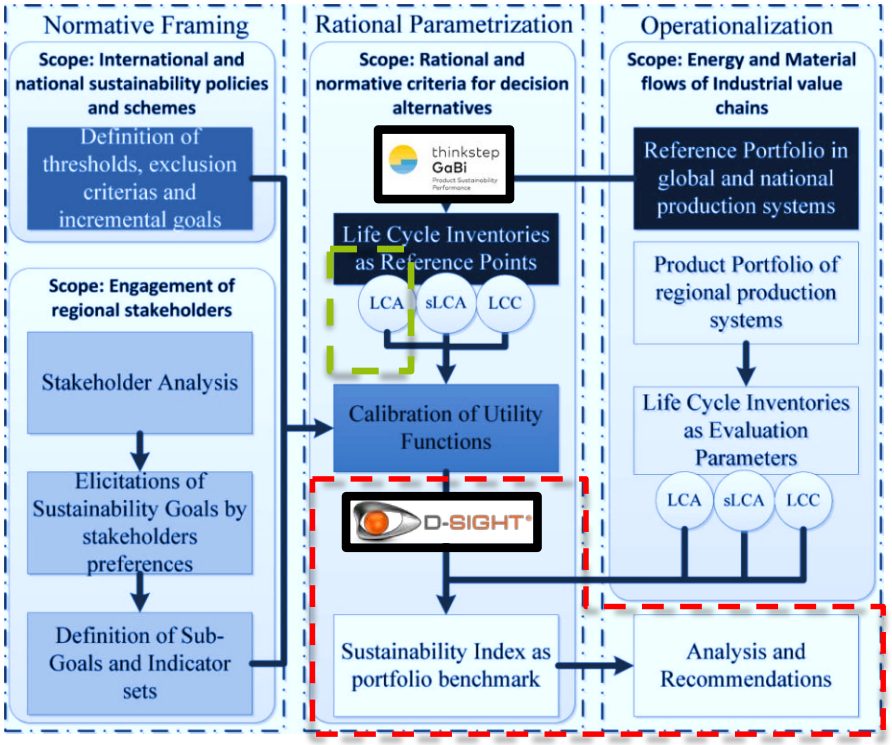
Source: Hildebrandt 2017, UFZ Final Workshop Bioeconomy

Establishment of a monitoring tool for the system analysis of the sustainability of bioeconomy regions

- *Establishment of a sustainability index for value chains in a bio-economy region*
- *Establishment of a regionally-differentiated social Life Cycle Assessment method*

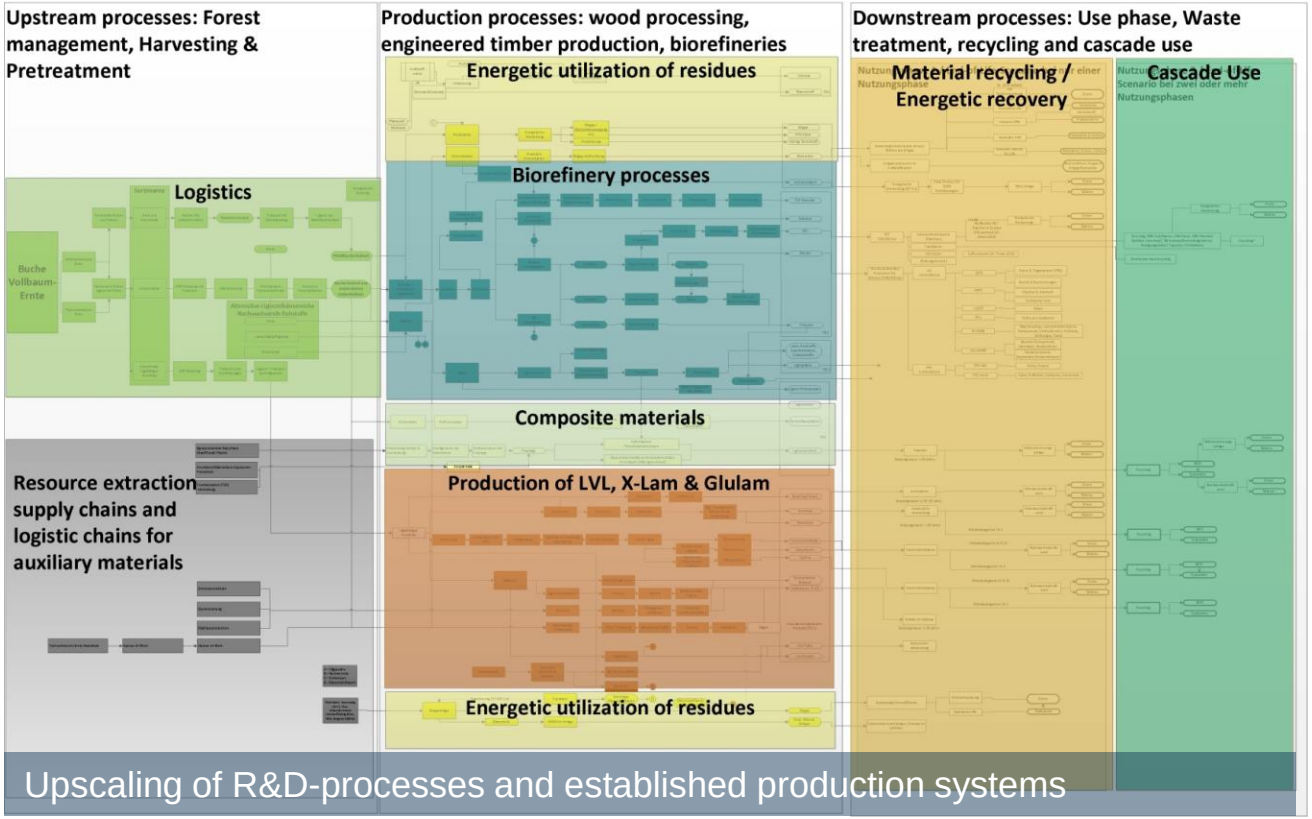
The SUMINISTRO framework

Sustainability monitoring Index for assessing regional bio-based industry networks



Bezama, A.; Siebert, A.; Hildebrandt, J.; Thrän, D. (2016). Integration of LCA, LCC and social LCA for assessing a bioeconomy Region: In book: Life Cycle Approaches to Sustainable Regional Development, Chapter: 37, Publisher: Taylor & Francis Ltd, Editors: Stefania Massari, Guido Sonnemann, Fritz Balkau, pp.7 (258 -264)

Assessing the complexity of a bioeconomy region



Source: Hildebrandt 2017, UFZ Final Workshop Bioeconomy

Product basket & The Reference System

http://dreamicus.com/

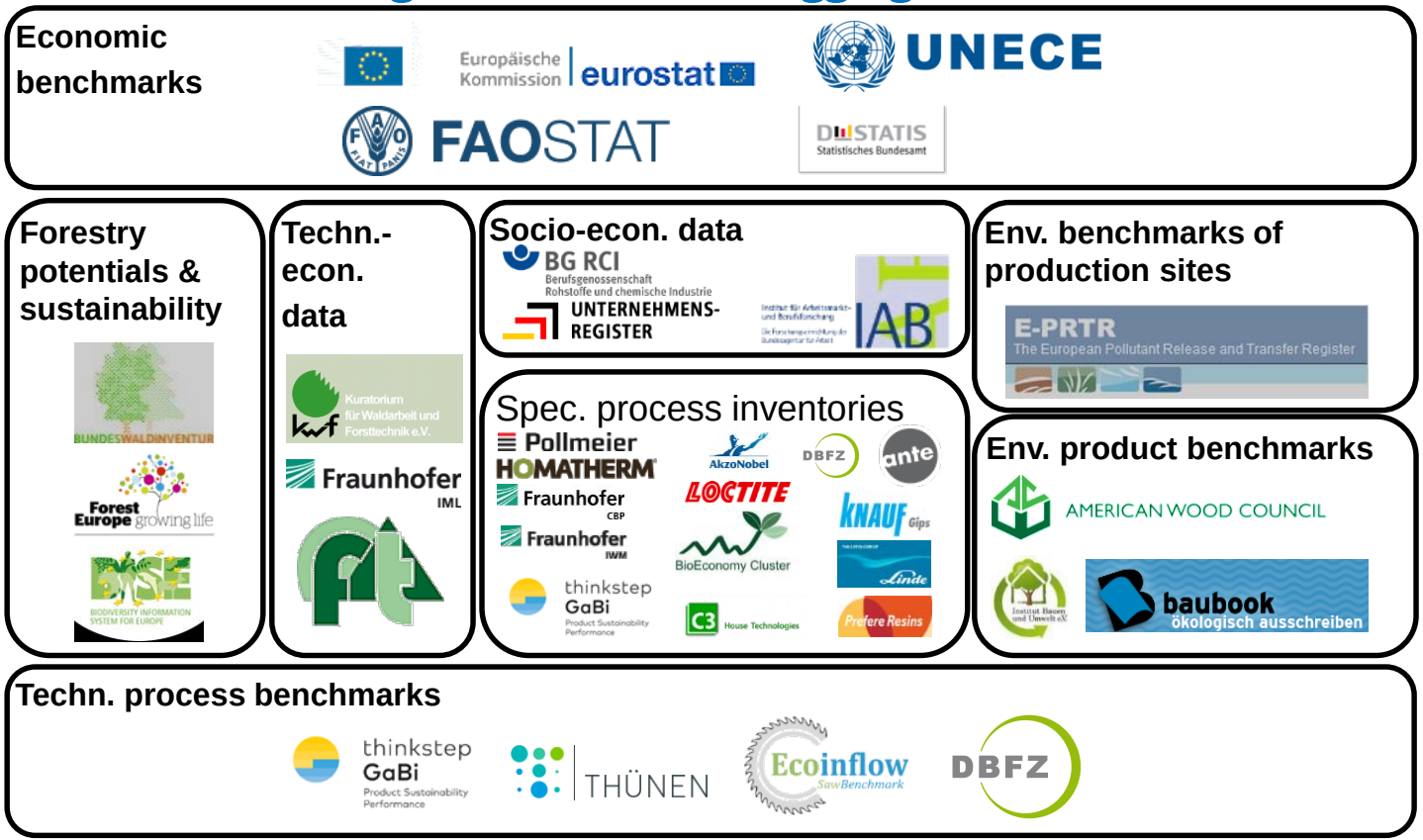
Functional capacity vs Mass

		Product basket - Bioeconomy Region	Reference Product Basket	
Energy (MJ grid)	40,000	Biomethane	Methane	40,000
W/m2*K	50,000	Expanded PLA	Expanded Polystyrene (EPS)	50,000
W/m2*K	10,000	Fibre reinforced composite and bio-foam	Polyurethane	12,500
Load bearing	50,000	Cross-laminated timber	Reinforced cocrete (load-bearing structure) + calcareous sandstone (excluding EPS)	325,000
W/m2*K	5,000	Wood fibre insulation board	Expanded Polystyrene (EPS) board	1,750
	Annual production volume (t/a)			Annual production volume (t/a)

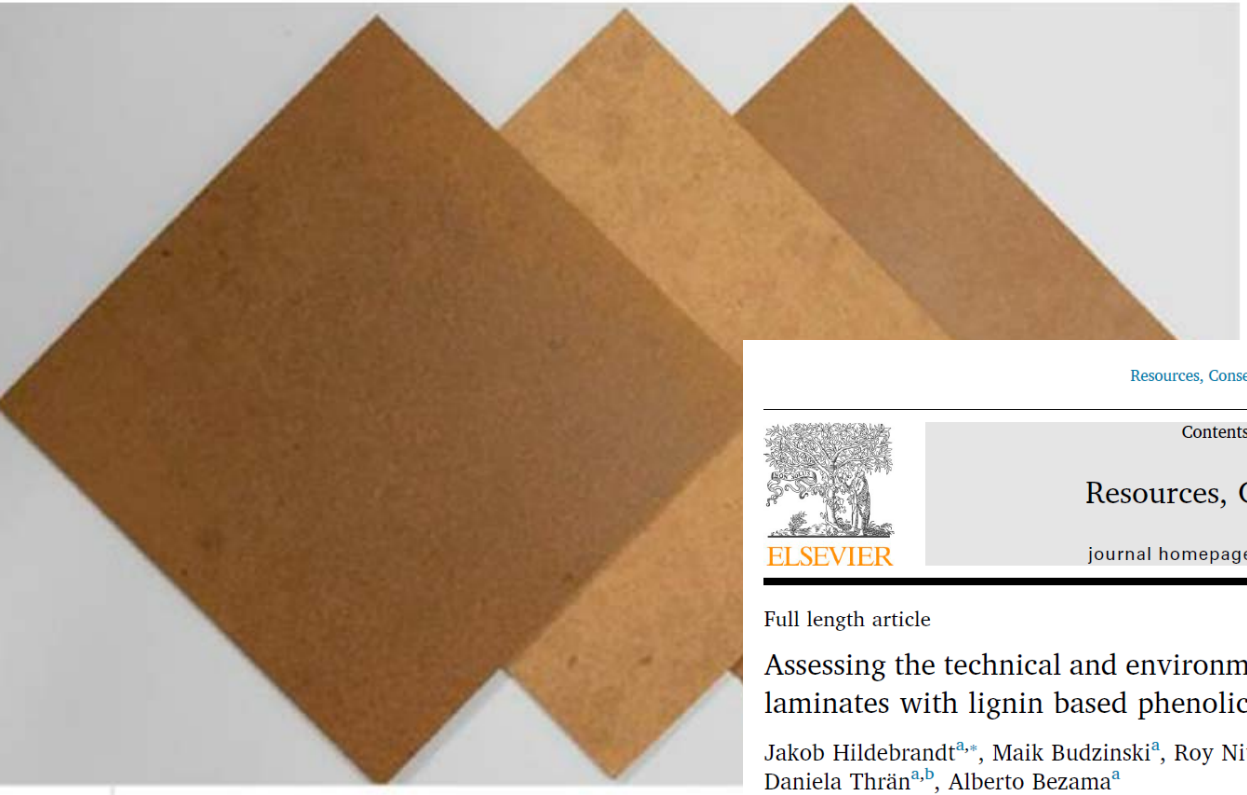
Biobased

Fossil based

Data sources along value chains and aggregation levels



Product design – LC-optimization



Resources, Conservation & Recycling 141 (2019) 455–464

Contents lists available at ScienceDirect

Resources, Conservation & Recycling

journal homepage: www.elsevier.com/locate/resconrec

Full length article

Assessing the technical and environmental performance of wood-based fiber laminates with lignin based phenolic resin systems

Jakob Hildebrandt[a,*], Maik Budzinski[a], Roy Nitzsche[b], Andreas Weber[c], Andreas Krombholz[d], Daniela Thrän[a,b], Alberto Bezama[a]

[a] Helmholtz-Centre for Environmental Research - UFZ, Department of Bioenergy, Permoserstr. 15, 04318, Leipzig, Germany
[b] Deutsches Biomasseforschungszentrum DBFZ gGmbH, Torgauerstr. 116, 04347, Leipzig, Germany
[c] Institut für Holztechnologie Dresden gemeinnützige GmbH, Zellescher Weg 24, 01217, Dresden, Germany
[d] Fraunhofer Institute for Microstructure of Materials and Systems IMWS, Group for Green Composites, Walter-Hülse-Straße 1, 06120, Halle (Saale), Germany

Product design – LC-optimization

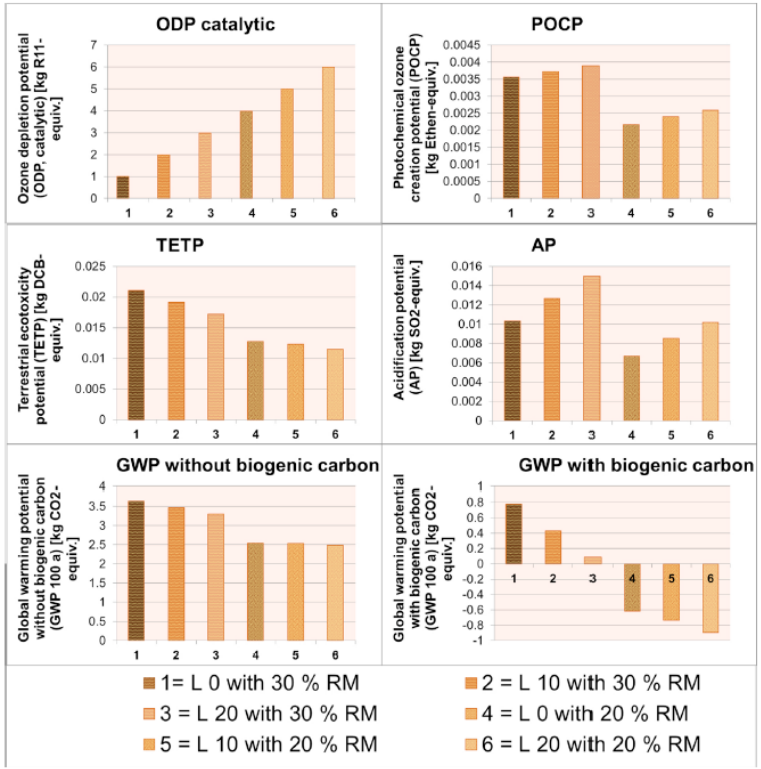


Fig. 4. LCIA results for the impact categories ODP, POCP, TETP, AP and GWP with and without biogenic carbon for comparing the impact of the six alternative product compositions.

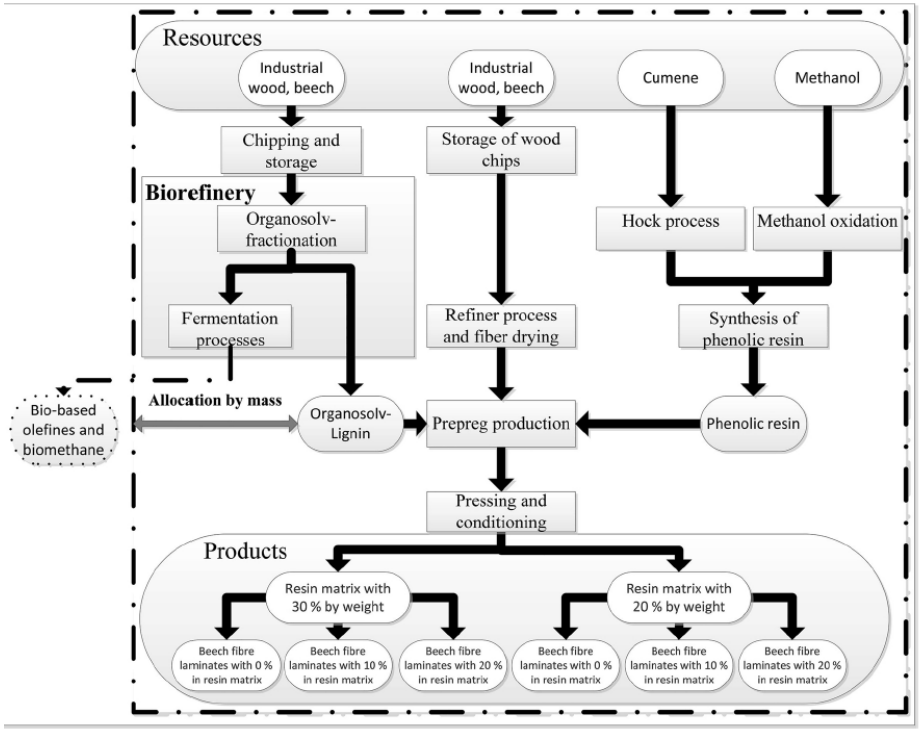


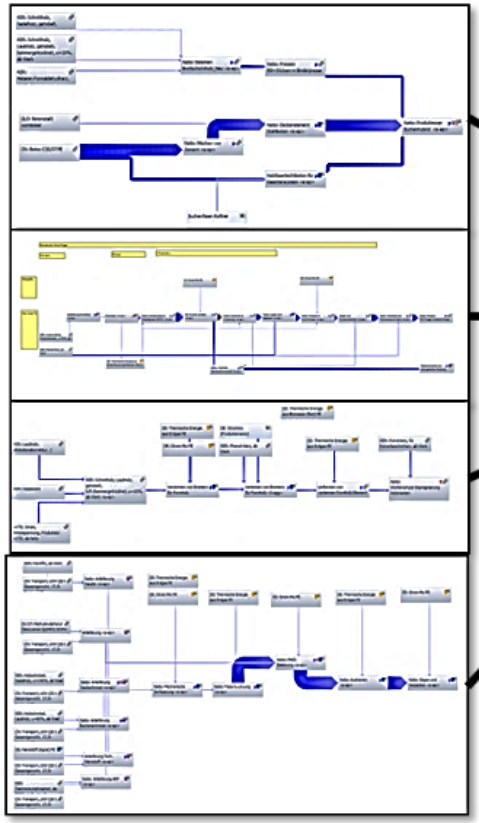
Fig. 2. System boundaries and alternative product compositions.

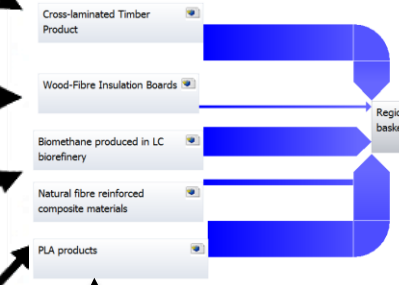
Calculation of the overall effects

Individual product chains

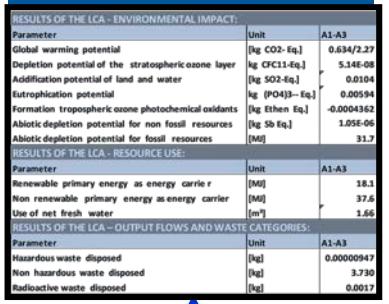
Product basket

Life Cycle Impacts





RESULTS OF THE LCA - ENVIRONMENTAL IMPACT:		
Parameter	Unit	A1-A3
Global warming potential	[kg CO2- Eq.]	0.634/2.27
Depletion potential of the stratospheric ozone layer	kg CFC11-Eq.]	5.14E-08
Acidification potential of land and water	[kg SO2-Eq.]	0.0104
Eutrophication potential	kg (PO4)3-- Eq.]	0.00594
Formation tropospheric ozone photochemical oxidants	[kg Ethen Eq.]	-0.0004362
Abiotic depletion potential for non fossil resources	[kg Sb Eq.]	1.05E-06
Abiotic depletion potential for fossil resources	[MJ]	31.7
RESULTS OF THE LCA - RESOURCE USE:		
Parameter	Unit	A1-A3
Renewable primary energy as energy carrie r	[MJ]	18.1
Non renewable primary energy as energy carrier	[MJ]	37.6
Use of net fresh water	[m³]	1.66
RESULTS OF THE LCA – OUTPUT FLOWS AND WASTE CATEGORIES:		
Parameter	Unit	A1-A3
Hazardous waste disposed	[kg]	0.00000947
Non hazardous waste disposed	[kg]	3.730
Radioactive waste disposed	[kg]	0.0017



Regional product basket <e-ep>

VS

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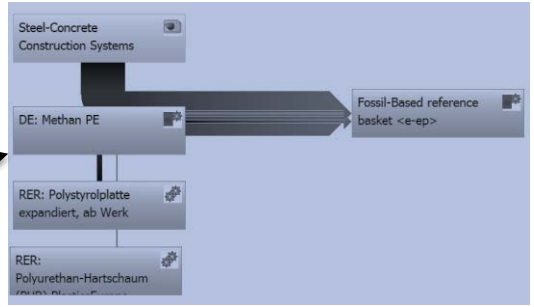


Overview of Potential Future Production Scenarios for our Regional product basket

RESEARCH AND ANALYSIS

Revealing the Environmental Advantages of Industrial Symbiosis in Wood-Based Bioeconomy Networks

An Assessment From a Life Cycle Perspective

Jakob Hildebrandt,[1] *Sinéad O'Keeffe*,[1] *Alberto Bezama*,[1] *and Daniela Thrän*[1,

[1]*Department of Bioenergy, Helmholtz Centre for Environmental Research – UFZ, Leipzig, Germany*
[2]*Deutsches Biomasseforschungszentrum gGmbH – DBFZ, Leipzig, Germany*

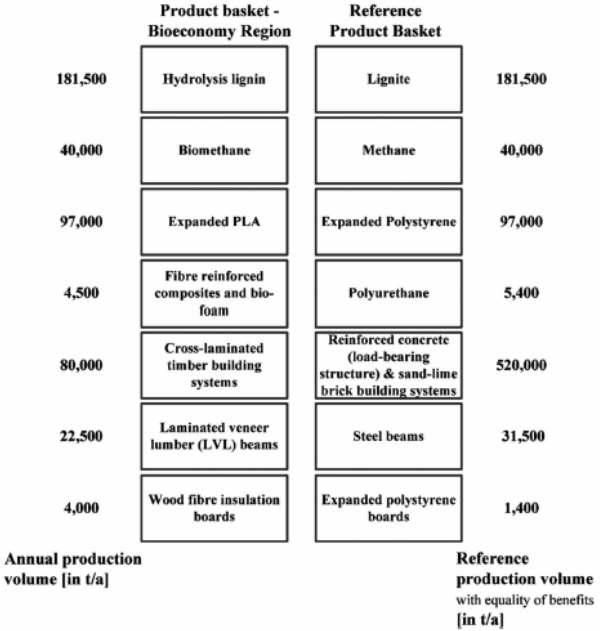


Figure 3 Annual production volume of wood-based materials in the baseline case, Scenario 2 (modified from Hildebrandt and colleagues [2017b]).

Overview of Potential Future Production Scenarios for our Regional product basket

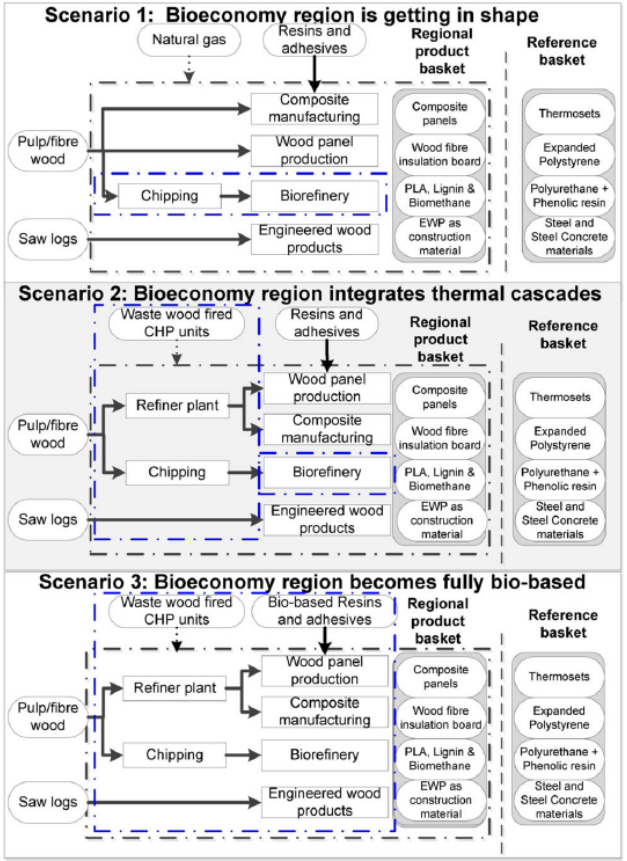


Figure 2 System boundaries and scenarios for the integration of value-added chains in the wood-based bioeconomy (Scenario Sc 1 was modified from Hildebrandt and colleagues [2017b]). (For each scenario the upstream and downstream processing paths where integration takes place are highlighted with blue and dashed lines.) See Table 2 for explanation of acronyms.

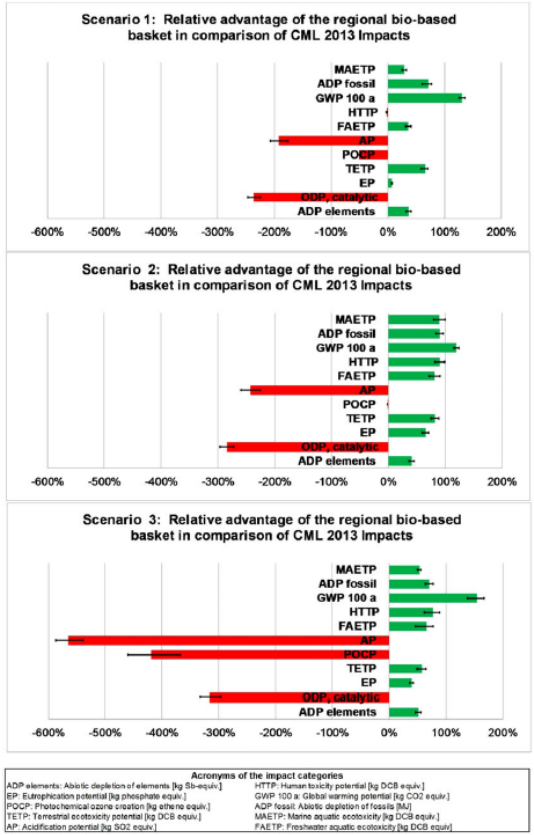
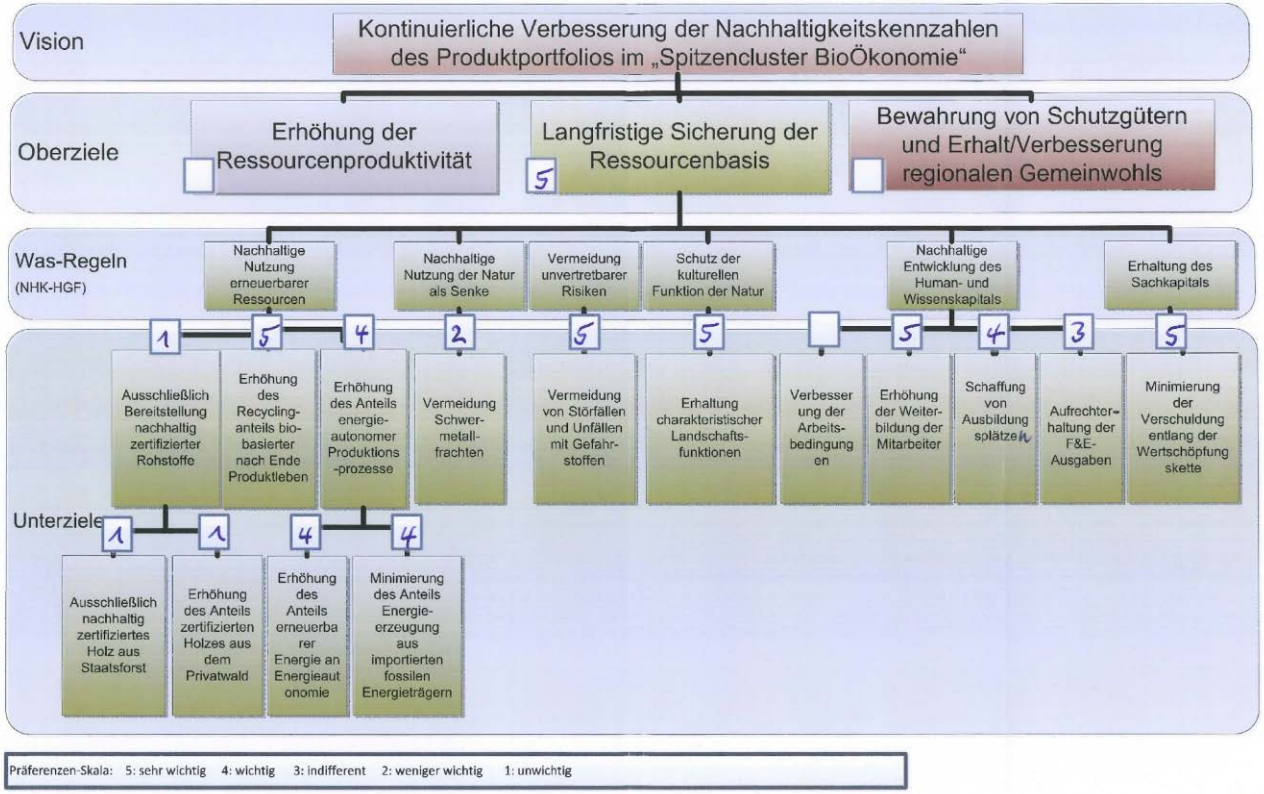


Figure 4 Scenarios 1–3 life cycle impact assessment comparison of the relative advantage of bio-based products in minimizing the environmental impacts over fossil-based references (green highlights benefits for the bio-based products, and red highlights benefits for the fossil-based references) (Scenario 2 was modified from Hildebrandt and colleagues [2017b]). (See Table 4 for explanation of acronyms.)

Stakeholder involvement in setting management goals



Quelle: Hildebrandt 2018, Promotionsschrift, "Monitoring the sustainability of added-value networks in bioeconomy regions

Scenario analysis of industrial integration in a Bioeconomy Region

sustainability

MDPI

Article

Insights from the Sustainability Monitoring Tool SUMINISTRO Applied to a Case Study System of Prospective Wood-Based Industry Networks in Central Germany

Jakob Hildebrandt [1,2,*], Alberto Bezama [1] and Daniela Thrän [1,3]

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2 Faculty of Natural and Environmental Sciences, Zittau/Goerlitz University of Applied Sciences, 02763 Zittau, Germany
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Received: 1 April 2020; Accepted: 7 May 2020; Published: 10 May 2020

check for updates

Scenario analysis of industrial integration in a Bioeconomy Region

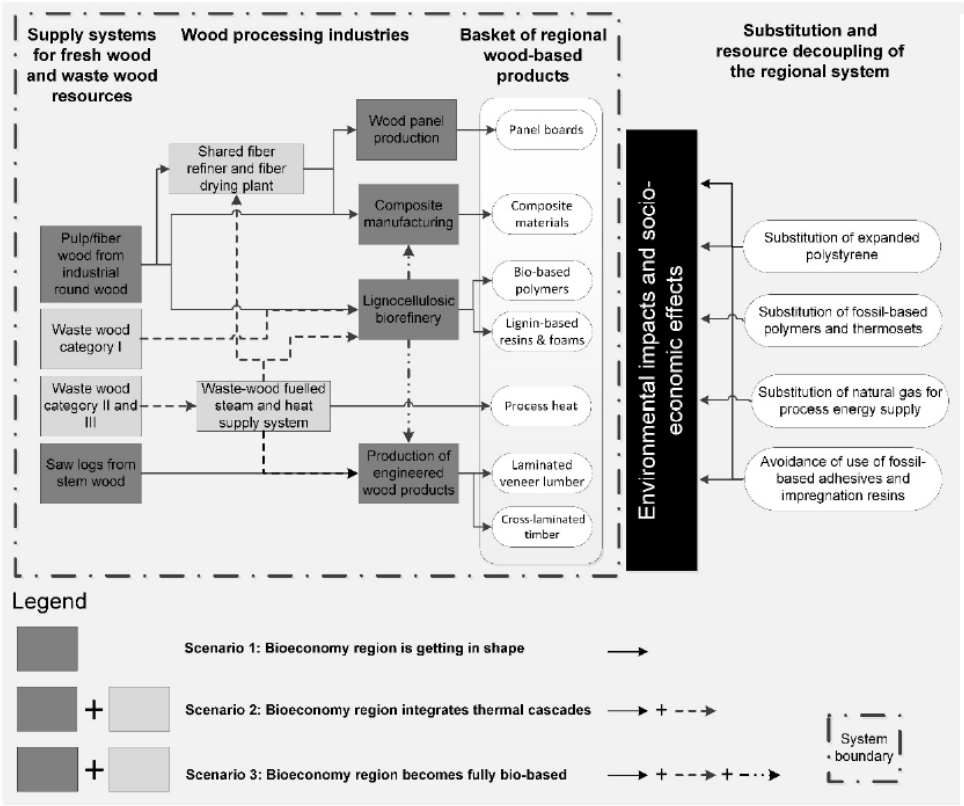

Figure 3. Substitution pathways in the wood-based production networks for the three scenarios.

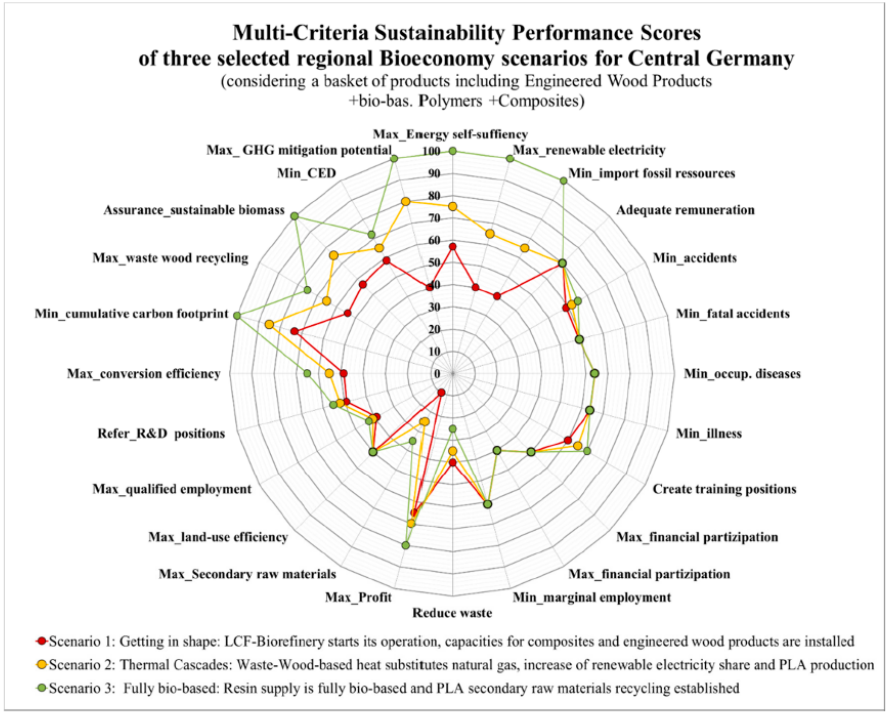

Figure 9. Multi-Criteria Sustainability Performance Scores of three selected regional wood-based bioeconomy scenarios for the case study region of Central Germany.

Key aspects of SUMINISTRO

- A **management tool** based on sustainability indicators has been developed for a cluster region.
- The set of indicators covers the entire product life cycle and the three dimensions of sustainability.
- Their results can be used by managers for setting the cluster/ Network/ regional strategies.
- The methodology was implemented in the web tool D-Sight and can be used as Sustainability Dash Board.

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Lessons learned

What have we learned?

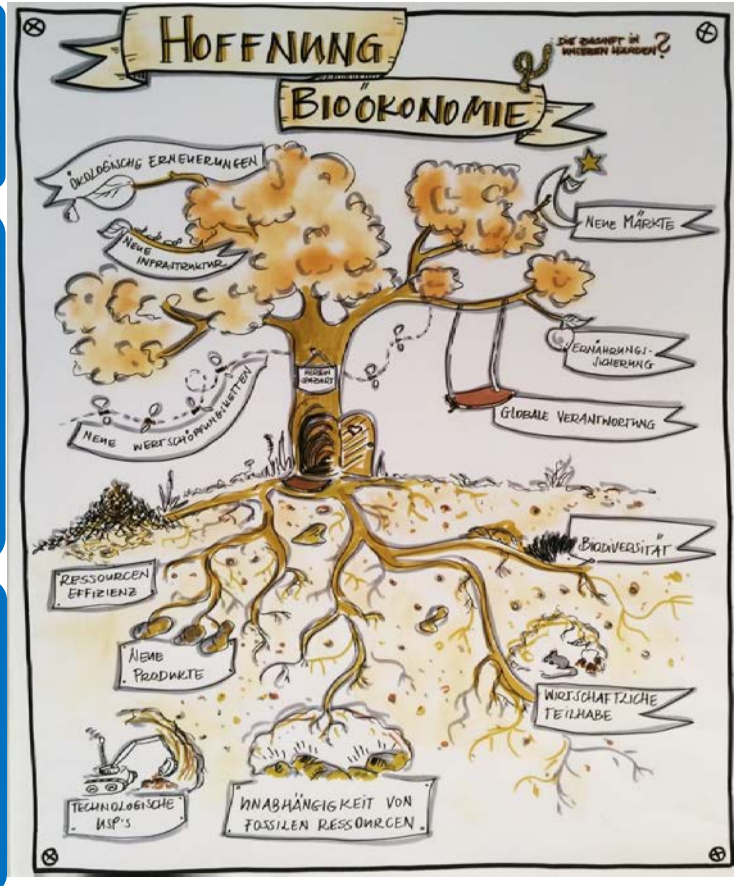
Source: Pixabay.com. User: PublicDomainPictures

Take home messages…

Bioeconomy is not per se sustainable

Bioeconomy must not be regarded as a substitution approach; it is rather an “innovation approach”

Great chances for climate protection, if the technologies are regarded within a more complex system



In order to achieve highest environmental advantages, technologies must be optimized and implemented with a coupled and cascade use orientation

A better understanding of the Bioeconomy System is necessary to be able to recognize and shape its opportunities and risks

Thank you for your attention !

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