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Life cycle engineering in the development of eco-efficient lightweight structures

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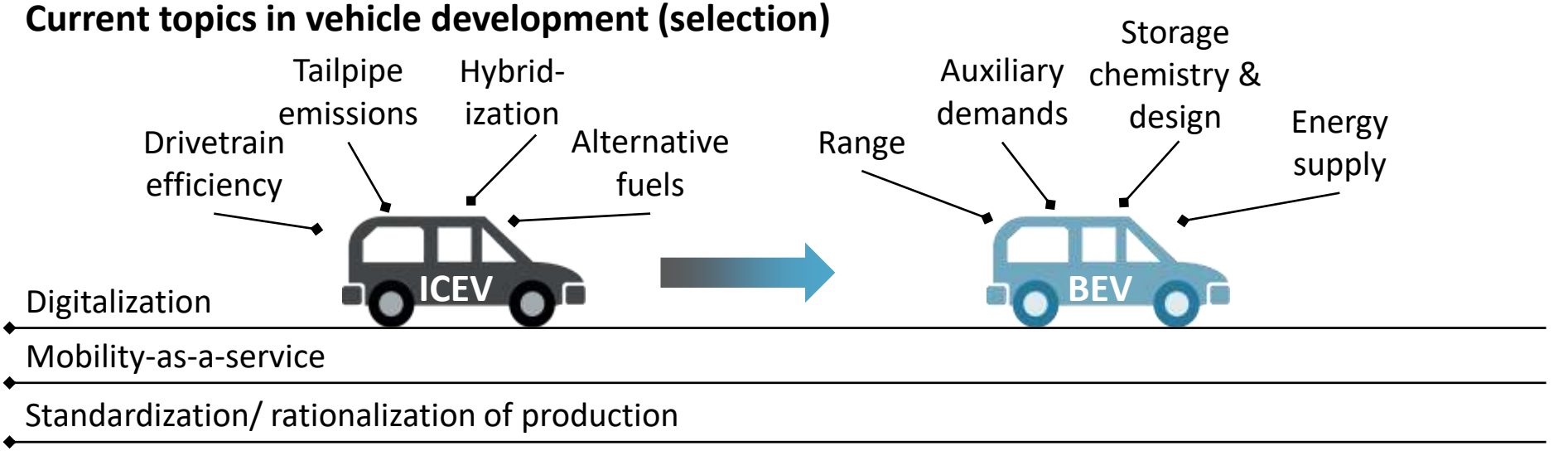
Current topics in vehicle development & levers of new manufacturing technologies

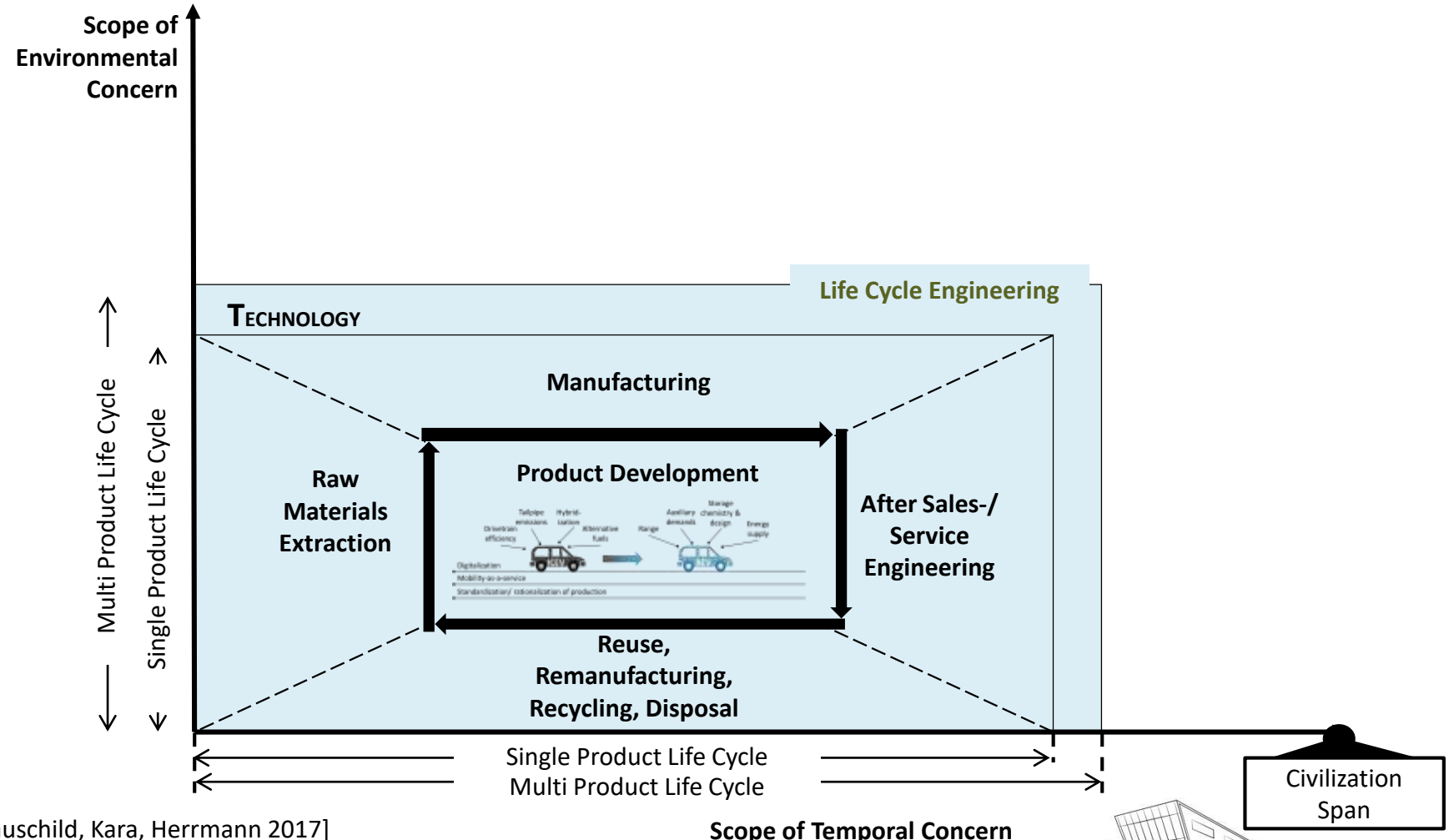
Levers of new manufacturing technologies for body-in-white

Current topics in vehicle development (selection)



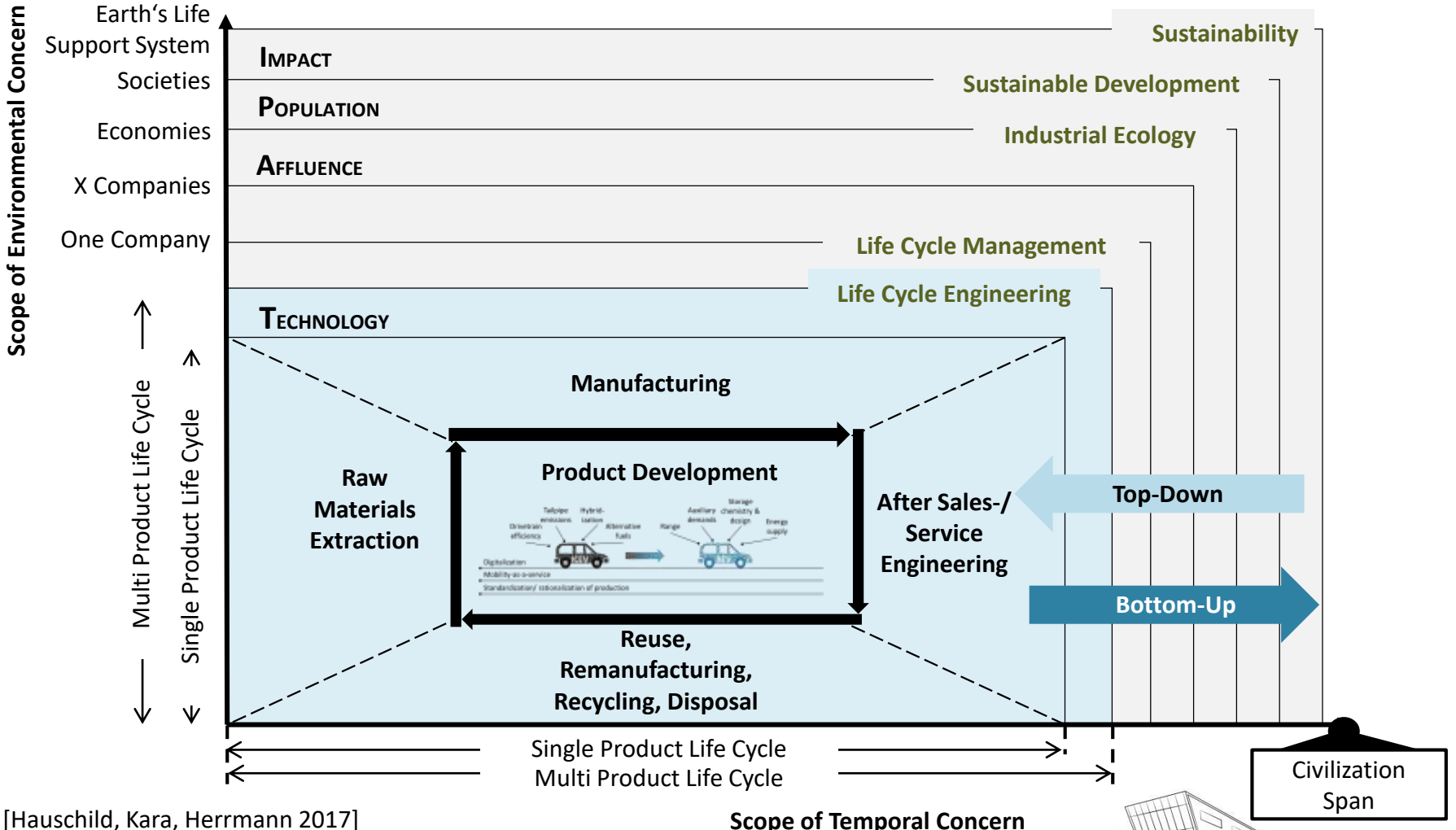
Adapted from [KPMG 2017]

Addressing the challenges through life cycle engineering



[Hauschild, Kara, Herrmann 2017]

Addressing the challenges through life cycle engineering



[Hauschild, Kara, Herrmann 2017]

System dependencies between product development and life cycle impacts for lightweight structures (exemplary)

Life Cycle Engineering

TECHNOLOGY

Manufacturing

Raw Materials Extraction

Share of secondary material

Process efficiency

After Sales-/ Service Engineering

Product Development

Embodied energy

Resource criticality

Use scenario

Energy supply

Young's modulus | Density | Wall thickn. | Width

Reuse, Remanufacturing, Recycling, Disposal

Process efficiency/ availability

Material quantity

Development targets

- Component weight
- Mechanical performance
- Environmental impact

Environmental intensity as type of eco-efficiency: "Environmental impact per unit of production value"

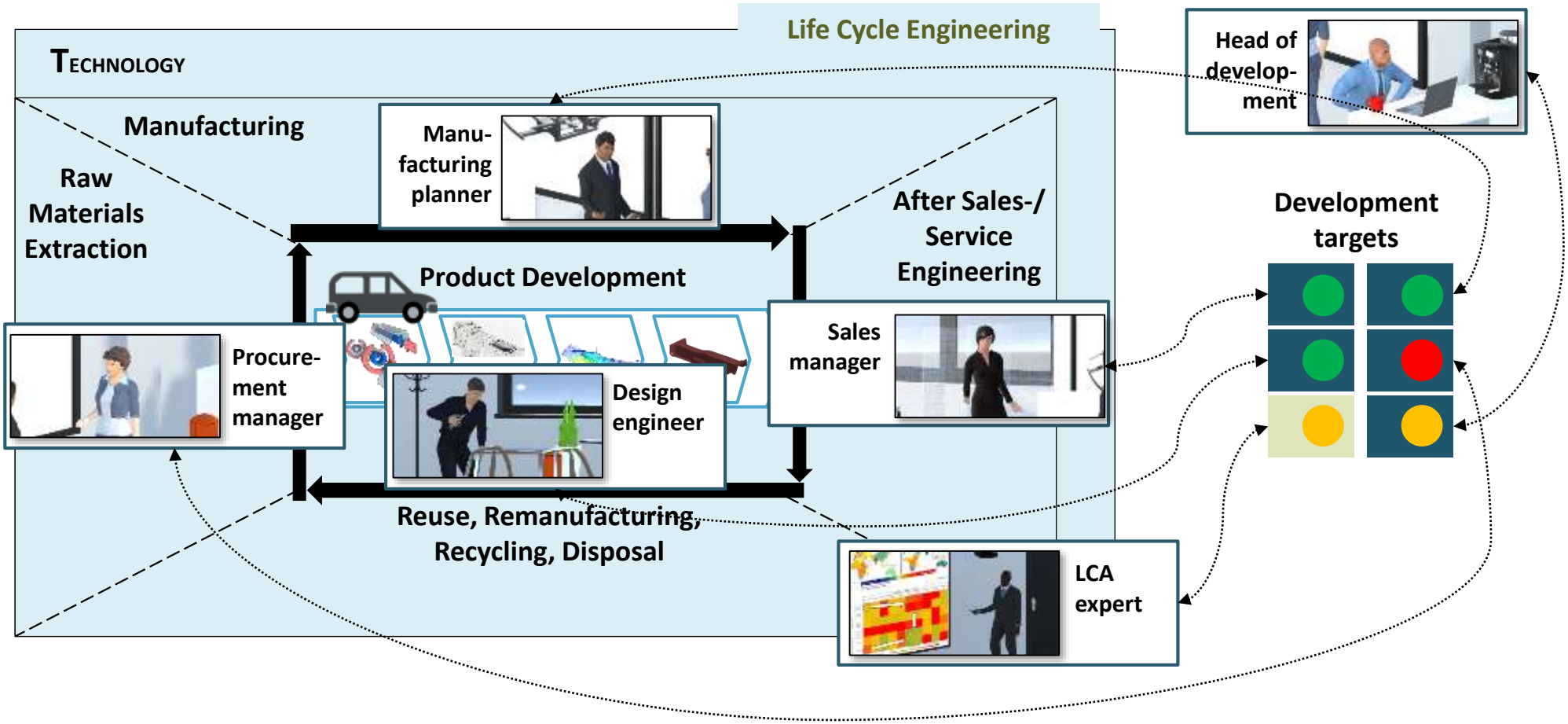
[Huppes & Ishikawa 2005]

Material profile

Geometry profile

LCA background system (in component develop.)

Actors with levers on life cycle impacts for lightweight structures (exemplary case)



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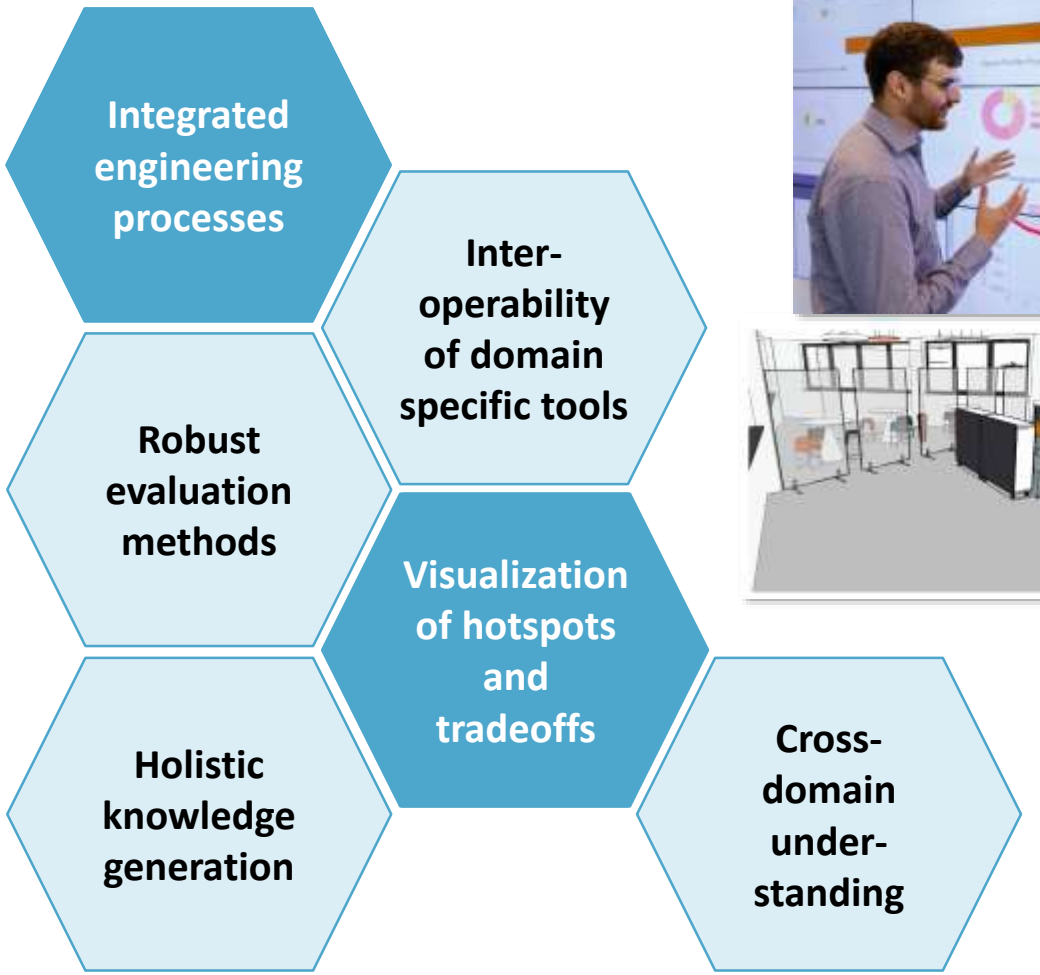
Life cycle engineering (LCE) support and exploration @Life Cycle Lab



LIFE CYCLE LAB
DESIGN & ENGINEERING

Life Cycle Lab

- Physical lab infrastructure @ OHLF shop floor level
- Flexible layout for different use cases in concurrent engineering
- Provision of domain-specific methods & tools
- Hard- & software to explore the potentials of visualization

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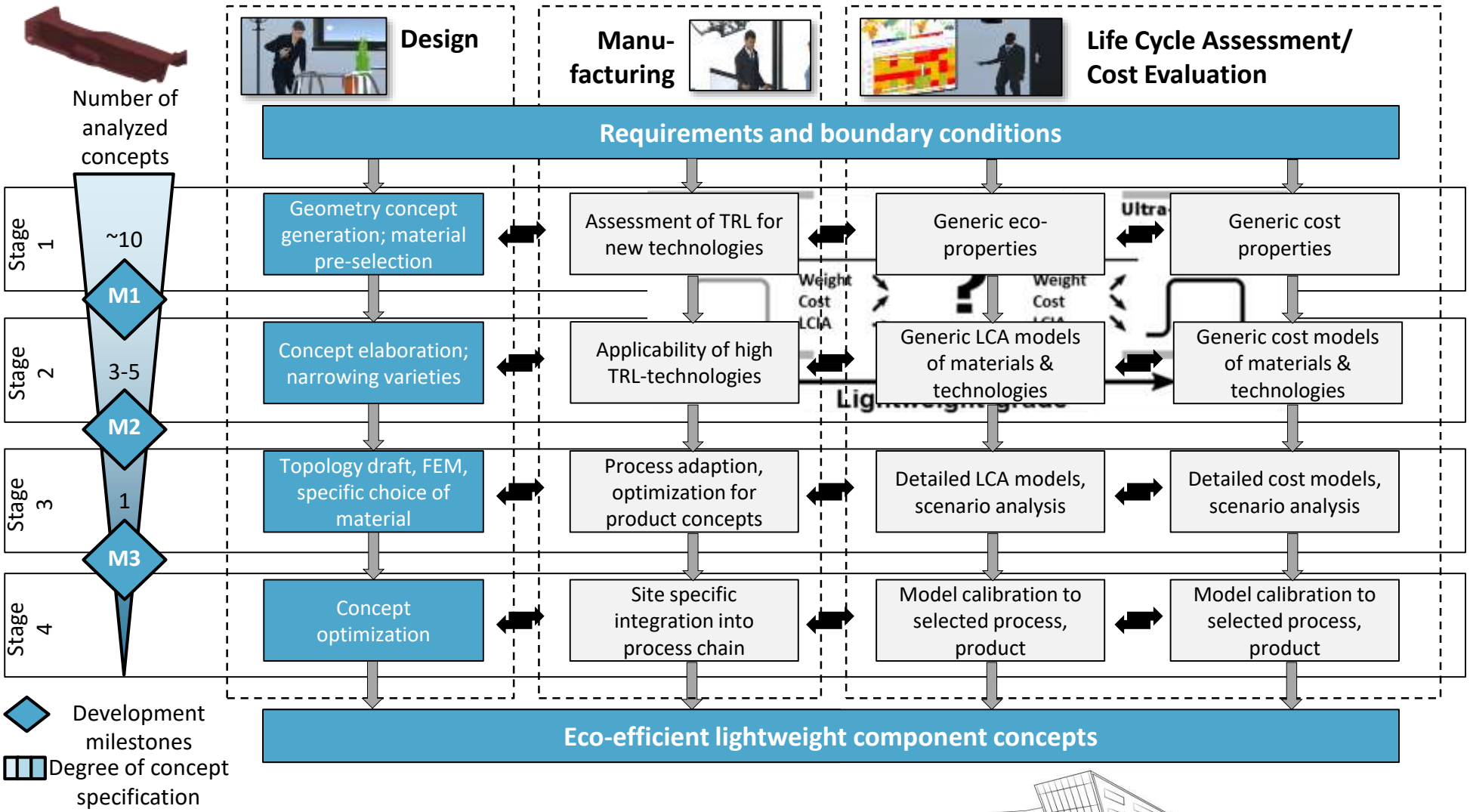
LCE support I | Integrated engineering processes



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LCE support II | Visualization of hotspots and tradeoffs
SETAC's capacity roadmap: Supporting Decision Makers with LCA

LCA expert

Design engineer

Head of development

	Results visualization	0-3 years	3-7 years	>7 years
12	Identify results visualization techniques that work for those *familiar with LCA*			
13	Create a decision tree to help in the selection of results visualization techniques			
14	Identify results visualization techniques that work for *engineers* (including those not familiar with LCA)			
15	Create a decision tree to help in the selection of results visualization techniques for engineers			
16	Identify results visualization techniques that work for *executives and/or policy makers.* (May need to consider compression and loss of information)			
17	Create a decision tree to help in the selection of results visualization techniques for executives and/or policy makers			
18	Identify results visualization techniques that work for *consumers* (consumer needs to be able to relate)			
19	Create a decision tree to help in the selection of results visualization techniques for consumers			

Solutions known, being optimized	Solutions available which may work	No known solutions
	Possible slippage due to technical difficulty	Possible slippage due to technical difficulty

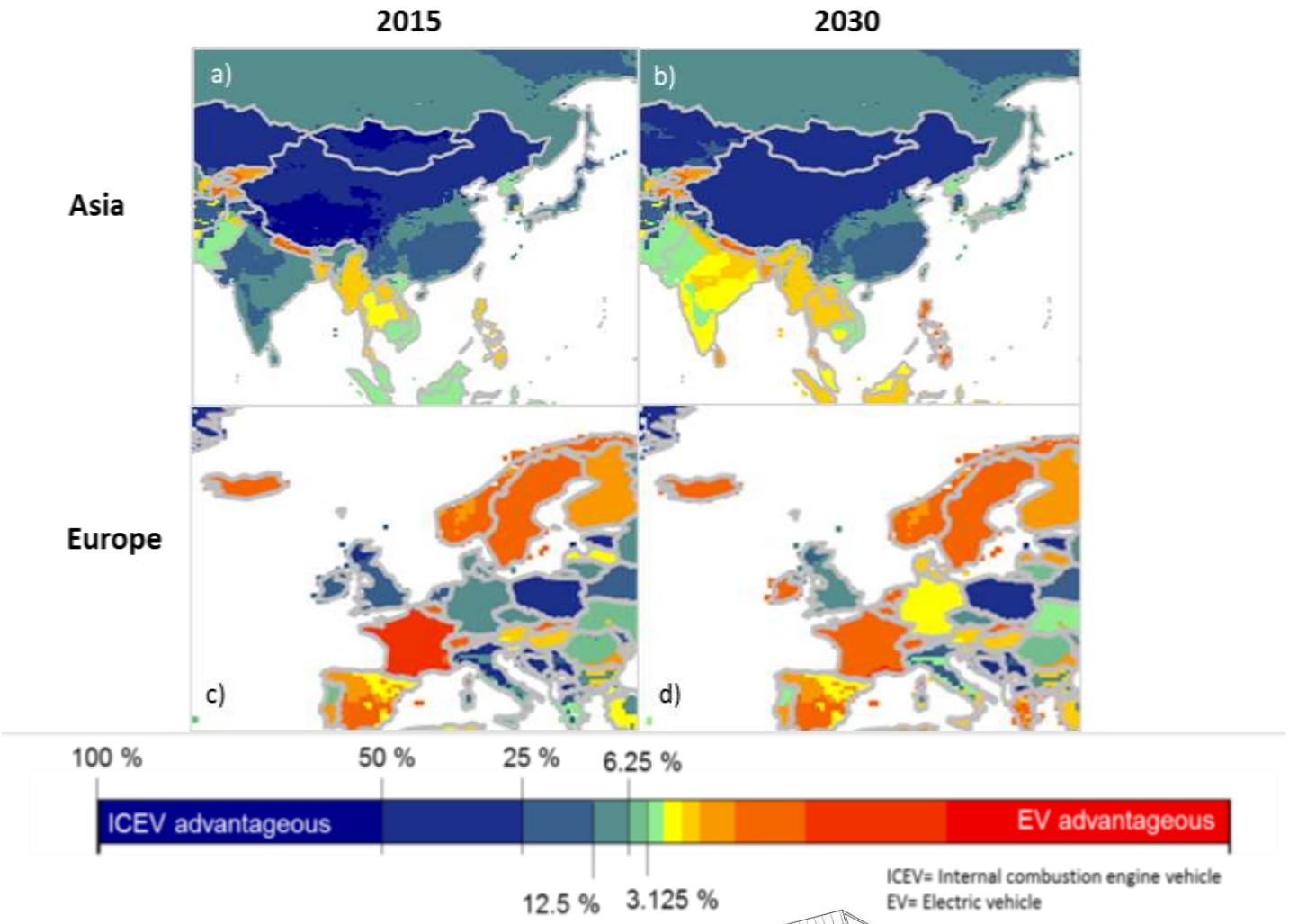
[Laurin and colleagues, 2016]

LCE support II | Visualization of hotspots and tradeoffs (example)
Spatial representations and future scenarios

LCA map for selected countries; climate change

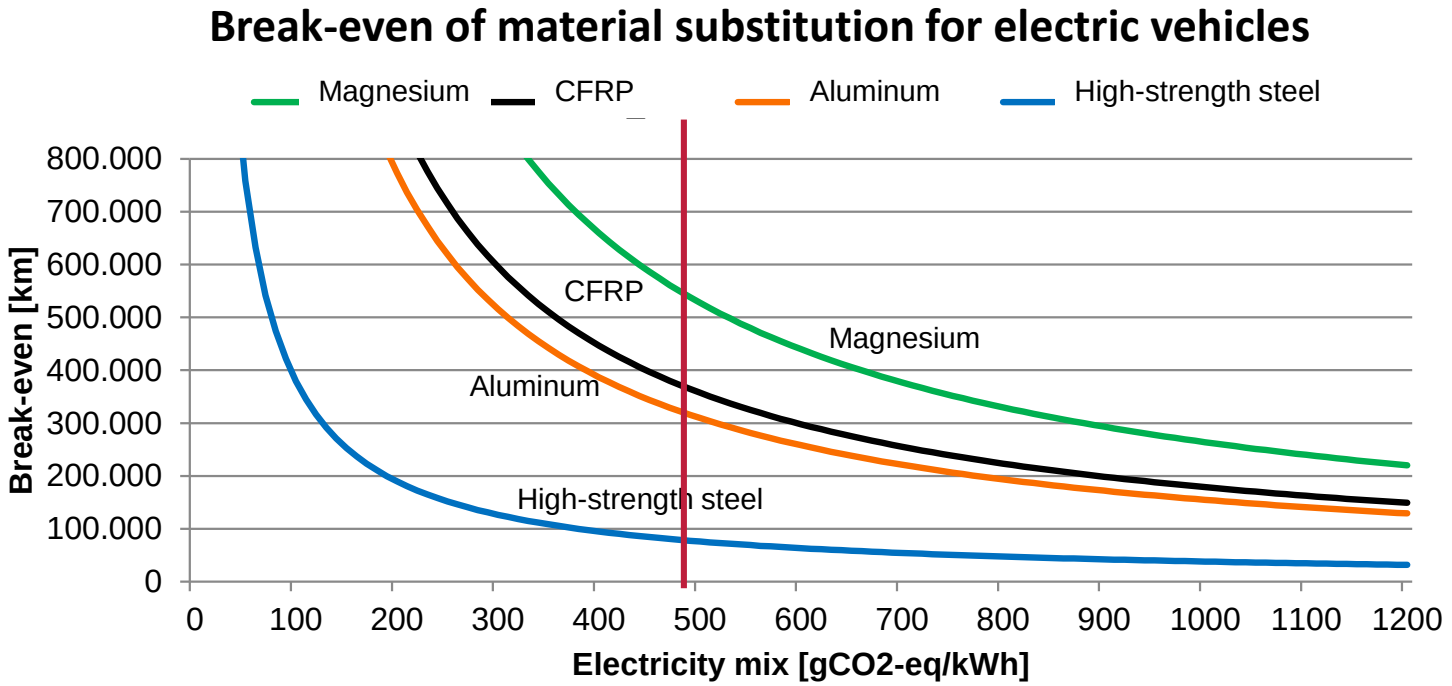
considering local climate and local electricity mix (2015) & targets (2030)

Scenario "Commuter“, "even use"



[Egede 2016; Erkisi-Arici et al. 2017]

LCE support II | Visualization of hotspots and tradeoffs (example)
Trade-off between manufacturing & use

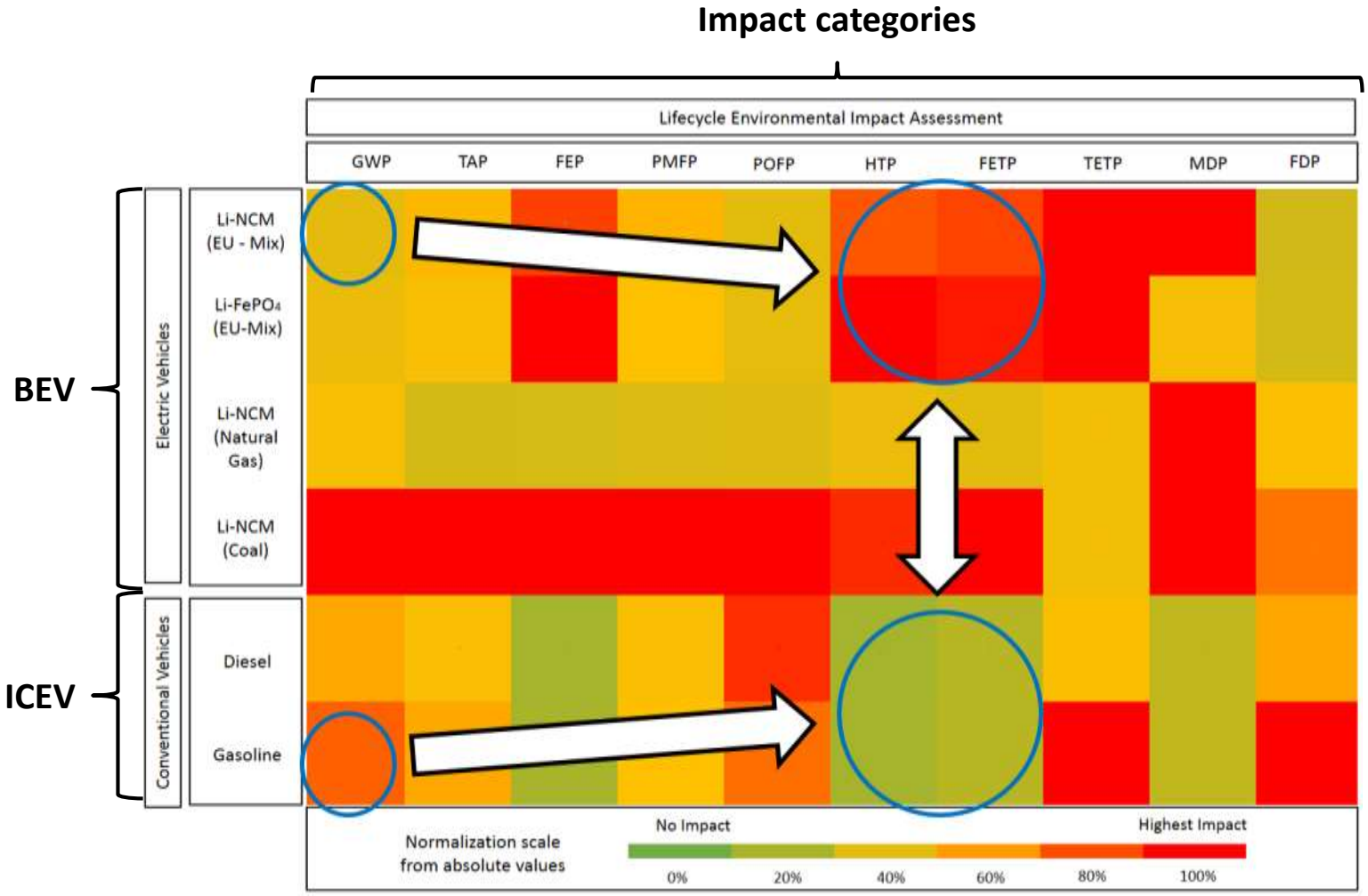


	Reference steel	High-strength steel	Aluminum	CFRP	Magnesium
GWP 1 kg material [kg CO2eq]	2.38	2.8	9.0	12.5	17.8
Substitution ratio	-	0.9	0.55	0.47	0.44
erv (Wh/km/kg)	0.0369				

[Egede 2016]

CFRP= Carbon fibre reinforced plastic

LCE support II | Visualization of hotspots and tradeoffs (example)
Cluster heat maps to facilitate LCA results interpretation



[Cerdas et al. 2017],
Data: [Hawkins 2013]

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Summary & Outlook

Summary:

- Complex interdependencies across disciplines in the development of eco-efficient vehicle structures

→ Adequate integration those disciplines as well as their methods & tools

- Life Cycle Lab @OHLF as physical research environment to explore potentials

Outlook:

- Extend scope towards further technological changes, e.g. functional integration
- Extend scope of methods and tools from technology to sustainability perspective
- Further elaboration of potential from visualization hard- and software
- Enhancement of methods to increase robustness in decision support

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Thank you for your interest!

Image: TU Braunschweig

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