

LCA on a Bus Body Component Based on Biomaterials

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Project

„Development and exemplary application of a body component based on renewable resources“

- Substitution of a body component of a MAN-passenger bus made of glass fibre reinforced polyester resin



- Application of the usual production technique (SMC-technology)

Team

- Engineering Corporation for Agriculture and Environment (German abbr.: Iglu), Göttingen
- Faserinstitut Bremen (FIBRE)
- Biocomposites and More (B.A.M.), Ipsheim
- NAFGO, Neerstedt
- Braunschweiger Kunststofftechnik (BKT)
- Technical University Braunschweig/Inst. for Geoecology

Financed by the ‚Deutsche Bundesstiftung Umwelt‘ (Projekt-N. 08448)



Basic Materials

Fibre

Experiments with different kind of fibres:

Hemp, cotton, flax

Bests results were achieved by the use of **hemp**.



Polymer

PTP[®] : (**P**olymer material made of **T**riglycerides and **P**olycarbon acid anhydrides)

resin component: plant oil

hardener component: carboxylic acid, ethanol

Petrochemical ingredients: 10-45 Mass%



PTP[®]-SMC-Paste

Technical Realisation



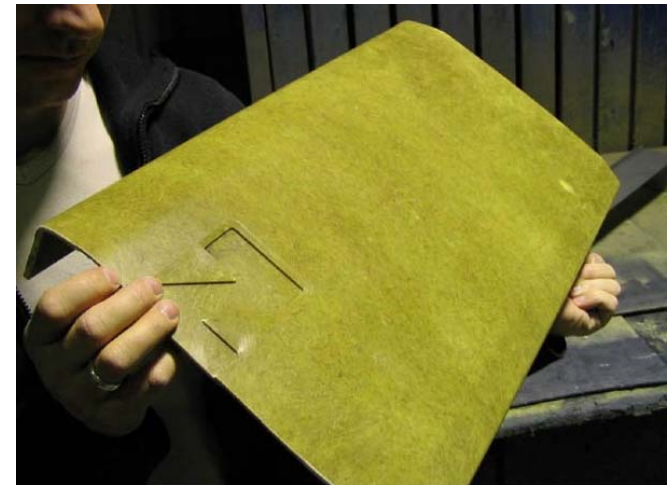
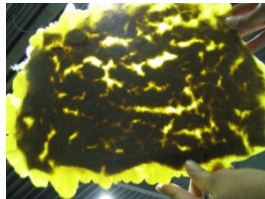
Press-moulding procedure:

Pressure = 180 bar

Temperature = 135°C

Pressing time = 10 min

Results:



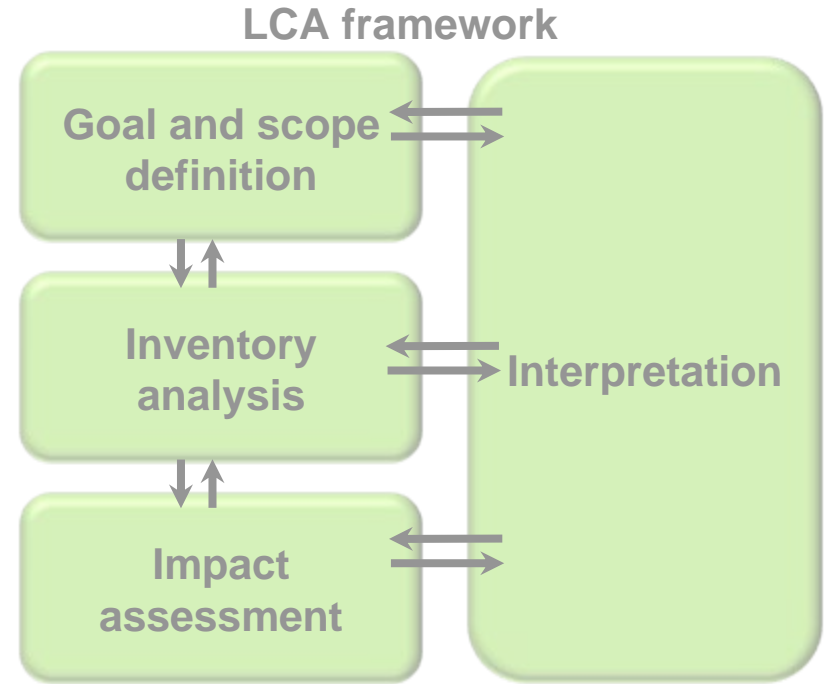
Results of the technical development

- Production of a homogenous component with a surface of high quality and best flame resistance
- Production with the series tooling of the company BKT, no procedural changes had to be done.
- The component succeeded the main points of the MAN norm.
- The on-road test was successful
 - over a year at a passenger bus in use.



Procedure of the LCA

- LCA according to DIN EN ISO 14.040 et seqq.
- Environmental impacts of the product about its entire life cycle
- Comparative balance between reference component (glass fibre reinforced polyester resin – *GF-UP*) and new developed components (nature fibre reinforced PTP – *NFK*)



Reference component



Body component made of glass fibre reinforced polyester resin (*GF-UP*); mass: 3.6 kg



Data sources:

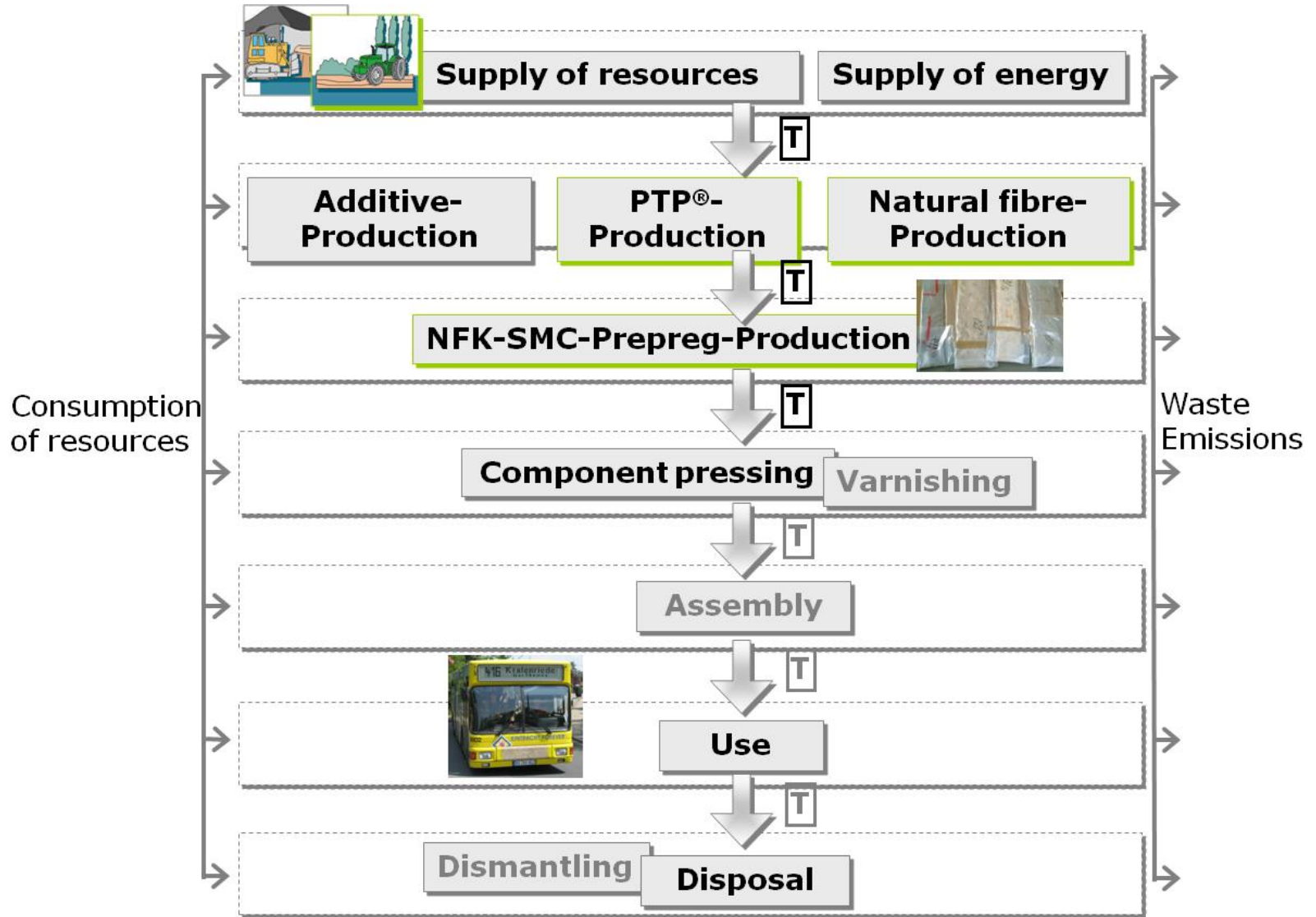
Industry data (B.A.M., BKT, NAFGO), agricultural institutions, databases for inventories (Ecoinvent, Umberto process library , ...)



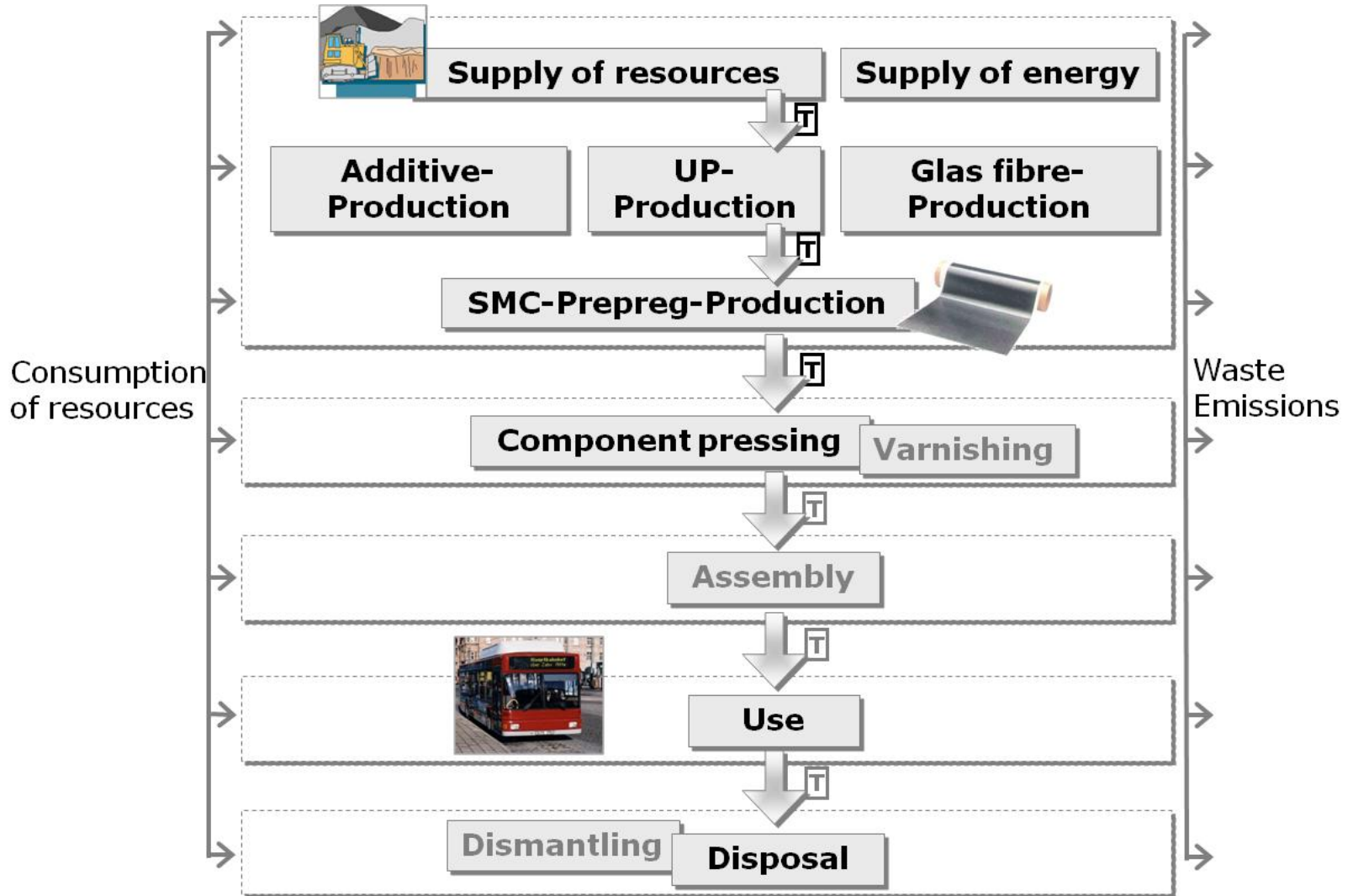
Software-Tool:

Umberto[®] from ifu Hamburg

System Boundaries: NFK-Bus Body Component



System boundaries: Reference GF-UP-component



Assumptions/excerpt:

- Co-products: mainly system expansion (alternative product supply and credit to the product system of the component)
- The reference to the cultivation of hemp was an annual actively vegetated fallow.
- Disposal: *VW-SiCon* process (dismantling, shredding, separation of materials, substitution of oil in blast furnace)

Variant	Description
<i>NFK I</i>	Hemp fibre-PTP [®] -material system with flame retardants; mass was comparable to the <i>GF-UP</i> component
<i>NFK_{opt}</i>	Optimised use of material at the prepreg-production
<i>NFK_{light}</i>	Light weight (reduction of the mass at 25%)

Estimation of the environmental impacts

Material- & Energy balance

Input	Output
Substance 1	Substance a
Substance 2	Substance b
....
Substance n	Substance x



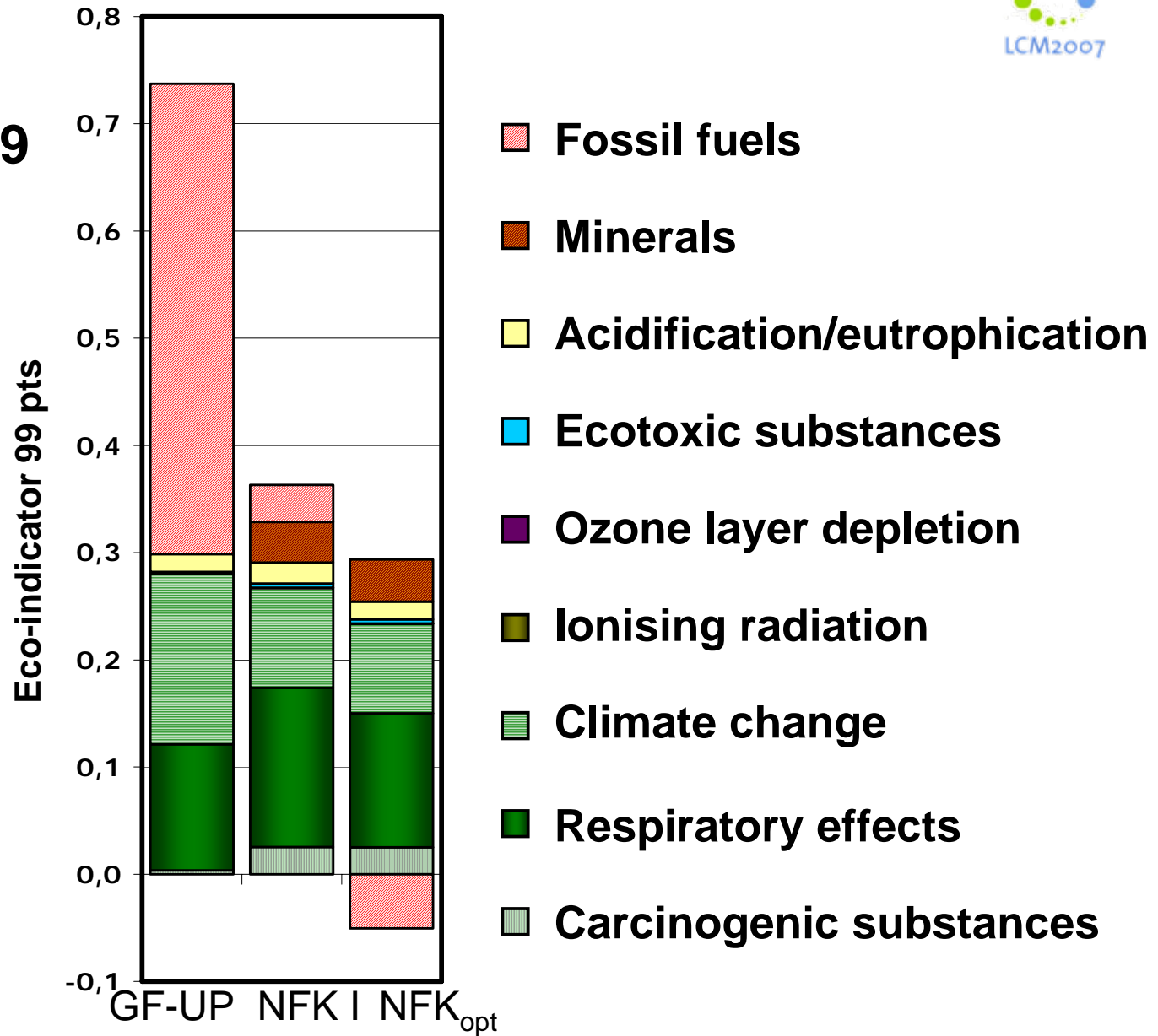
- **Cumulated Energy Demand (CED)** according to VDI-directive 4600
- Impact assessment with the methodology „**Eco-indicator 99**“

Eco-indicator 99:

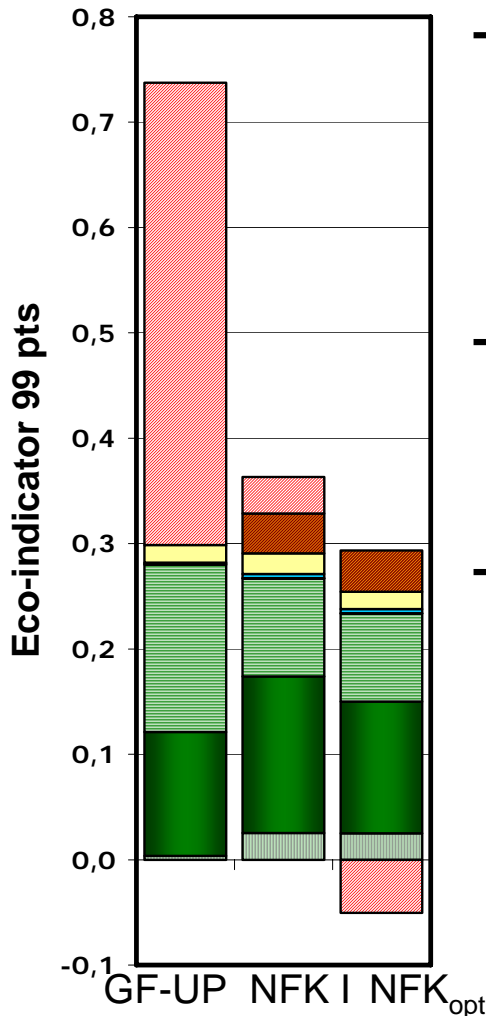
- Hierarchist perspective (H, A)

	Normalisation	Weights
Human Health	1.54 E-02	400
Ecosystem Quality	5.13 E-03	400
Resources	8.41 E-03	200

Results (1): Eco-indicator 99



Results (2): Eco-indicator 99

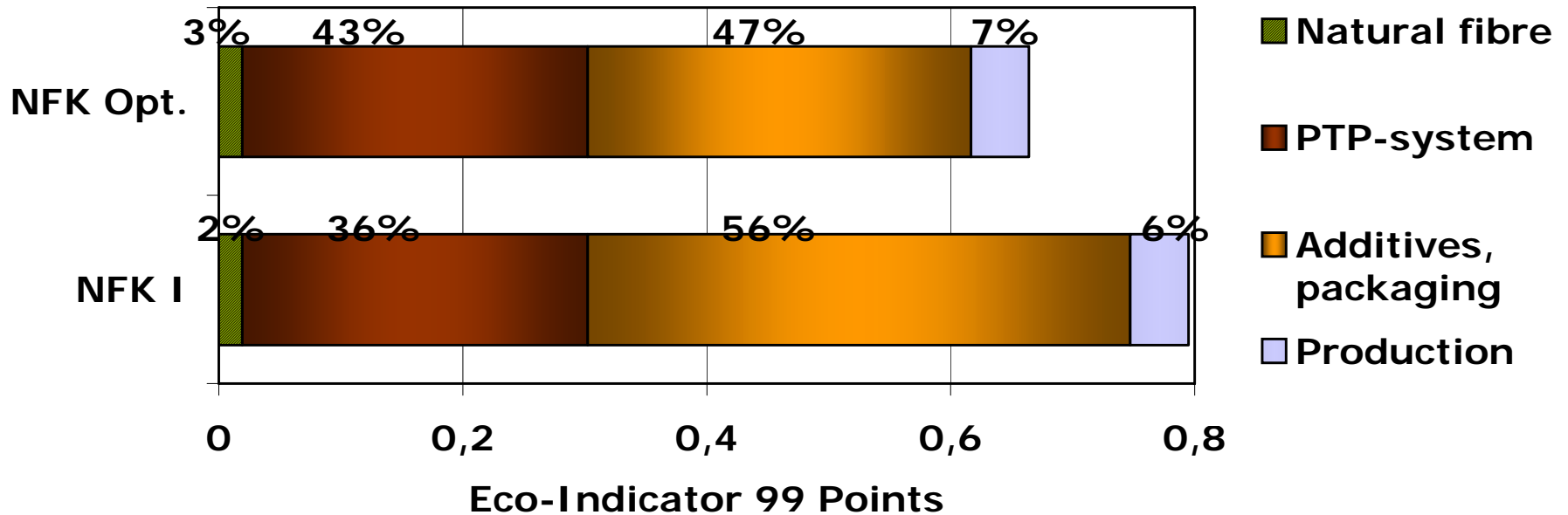


→ The components based on biomaterials had the lowest impacts referred to the *Eco-indicator 99* (-50 to -68%).

→ Above all, the categories *fossil energy* and *climate change* were dominant.

→ Categories *minerals*, *carcinogenic substances*: production of flame retardant had significant shares.

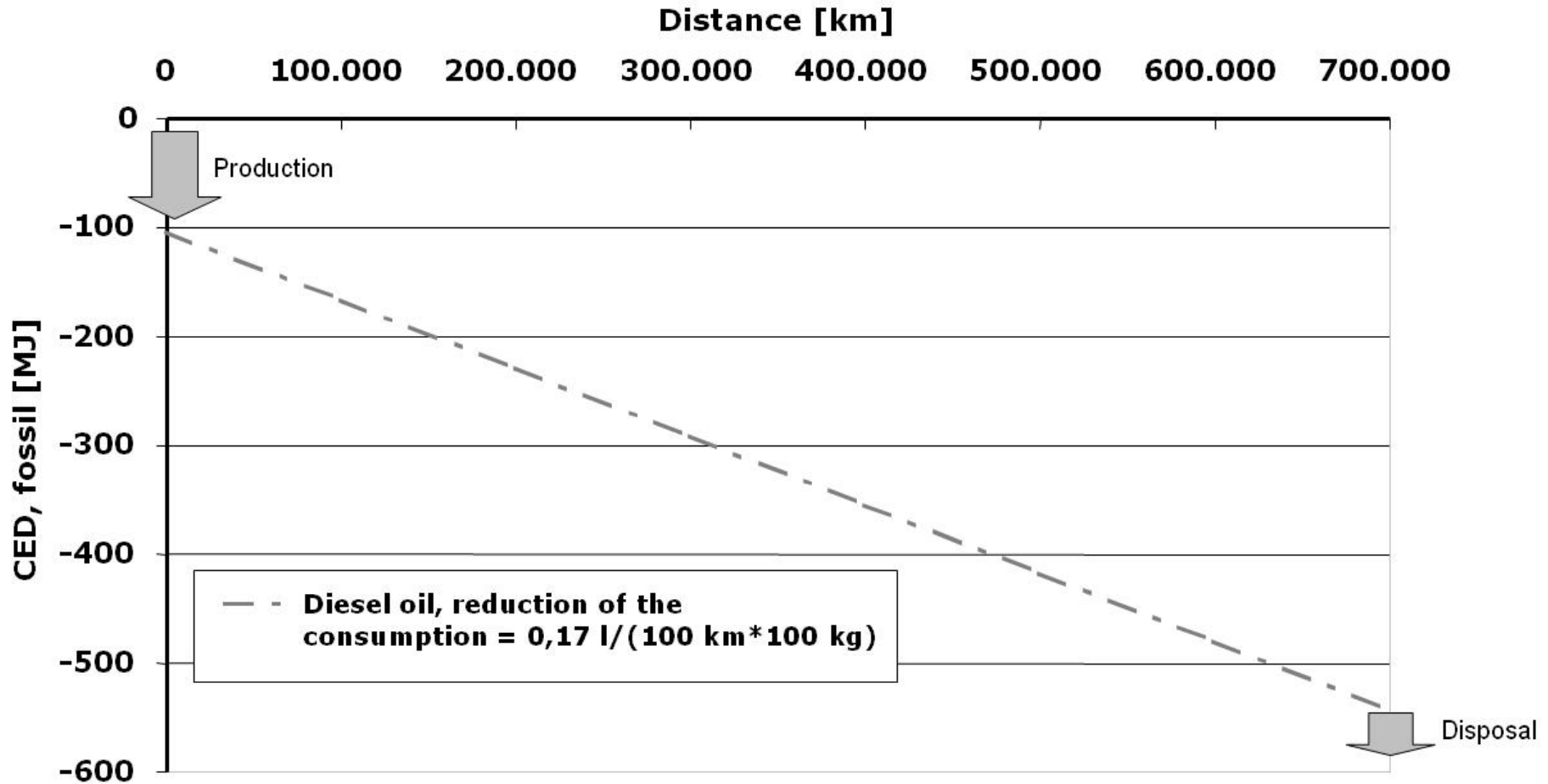
Results (3): Dominance analysis



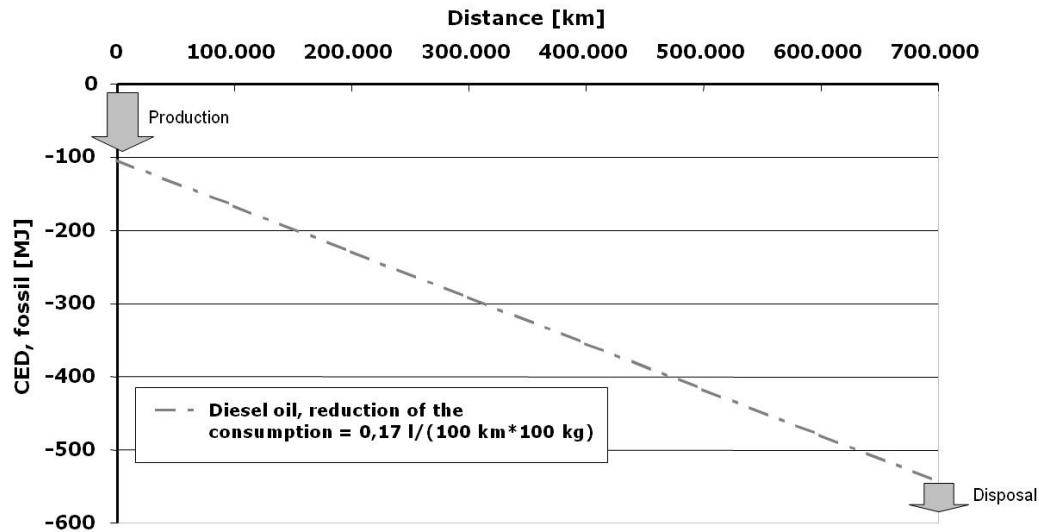
→ The production of the resin-hardener-system and additives had got strong environmental impacts.

→ Low impacts due to the cultivation of fibre plants and their further processing

Results (4): Saving of primary energy → NFK_{light} vs. GF-UP



Results (5)



→ The use phase of automotive components especially in the bus sector (high operating time) is very important .

→ At an average performance of 650 tkm petrol about 512 MJ could be saved.

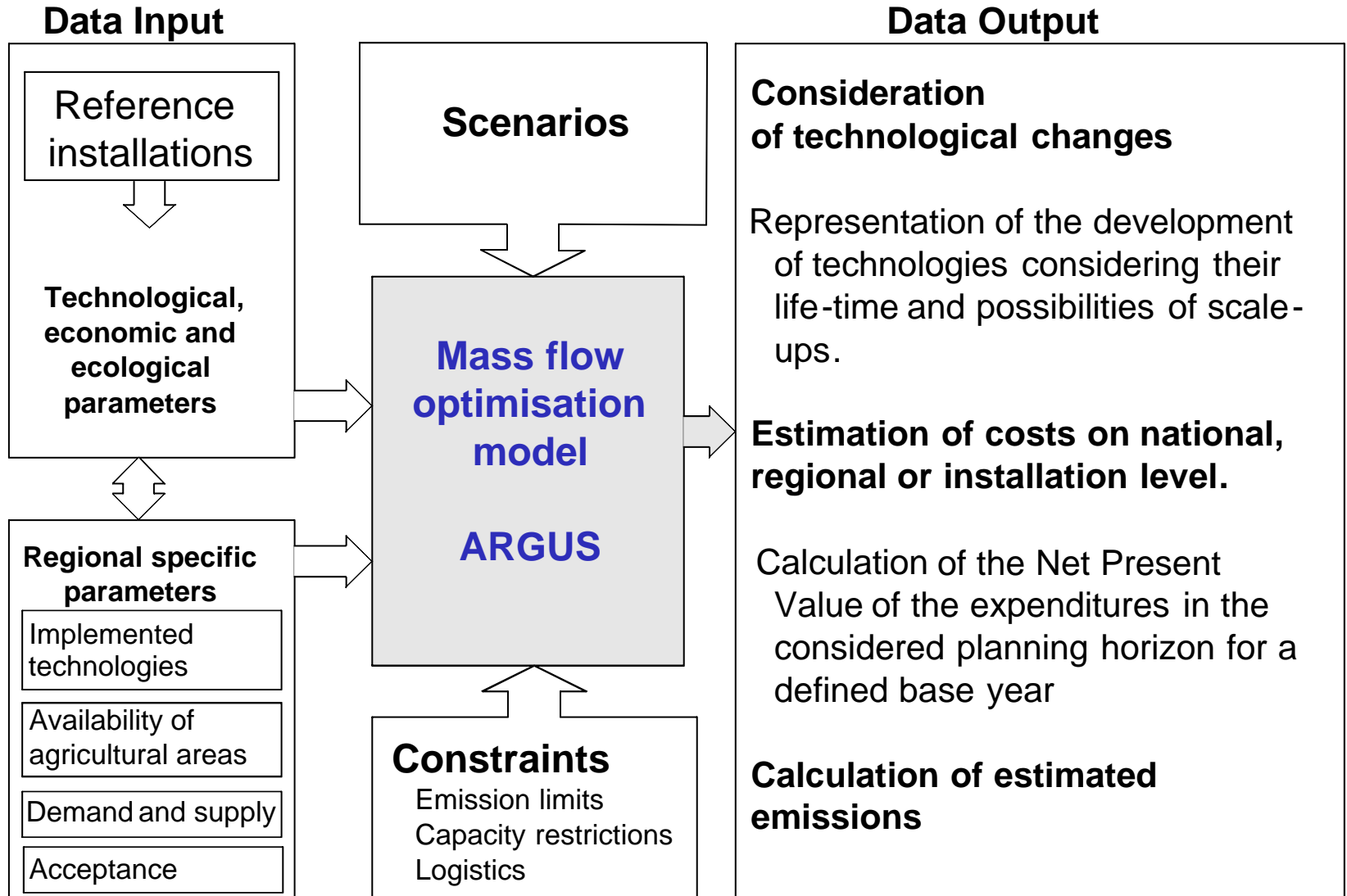
Summary

- Significant less environmental effects especially in the categories *energy resources* and *climate change*
- More efficient material use and less environmental effects were expected for the serial production of the *NFK*-component.

Suggestions

- Realisation of a light-weight-component
- Final analysis of the environmental effects caused by the serial production of the *NFK*-component (follow-up project)

Future prospects





Thank You for Your
Attention!