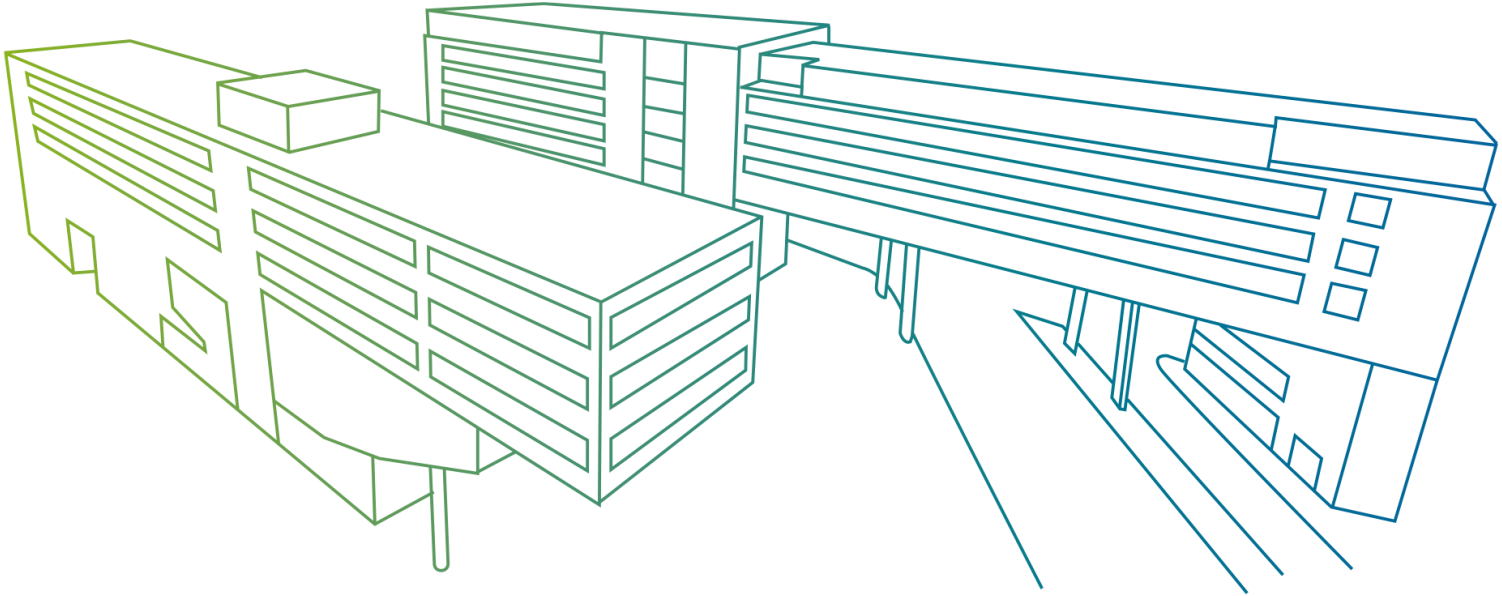


FH University of Applied Sciences TECHNIKUM WIEN

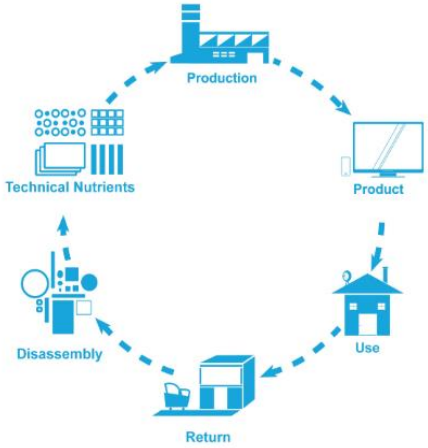
C2C - Technische Innovationen zur Kreislaufwirtschaft & Umweltbewertungsmethoden

FH-Prof. Mag. Dr. Martina Ortbauer

C2C - Cradle to Cradle

“Take, Make, Waste” versus “Reduce, Reuse, Recycle”

Biological Cycle
Consumption Products



Technical Cycle
Service Products

“Biological nutrients” **or** **“Technical nutrients”**

„Cradle to Cradle“

deutscher Verfahrenstechniker & Chemiker Michael Braungart gemeinsam mit William McDonough (amerikanischen Architekt)

„Das Konzept ist von der Natur inspiriert, in der es keinen „Abfall“ gibt. Abfall wird in der Natur als Nahrung verstanden. Die Bestandteile eines Produktes sollen demnach in biologischen und technischen Nährstoffkreisläufen zirkulieren und positive Effekte auf Umwelt und Gesundheit ausüben

https://www.c2cplatform.tw/en/c2c.php?Key=1

C2C - Technische Innovationen zu Kreislaufwirtschaft & Umweltbewertungsmethoden

Was braucht es dazu?

- Gesellschaftlicher Wandel & „Bewusstsein“
- Technologischer Fortschritt
- Ökonomie
- Ökologie

Forschung & Lehre

1. Wie bewerten wir die Auswirkungen auf die Umwelt?

   Case studies: Plastikfolie, Auto-/Fahrradreifen

2. Wie designe ich ein Produkt, Prozess,..? „Save & Sustainable by Design“

   Case study: Milchverpackungen

3. Wie kann technologischer Fortschritt helfen?

   Firmenkooperation

Practical assessment skills

Interdisciplinary skills

Systemische Bewertungsmethoden für Technik und Umweltmanagement

Kompetenzfelder Chemical Engineering & Ecotoxicology and Resilient Energy Systems

Gefördert von

Stadt Wien

DI Ursula Knaack, MSc (lead), CEE
FH-Prof. Mag. Dr. Martina Ortbauer , CEE
Natalie Taupe, PhD, RES
Matthias Malottke, MSc, RES
Mag. Dr. Susanne Schidler, RES

Systemische Bewertungsmethoden für Technik und Umweltmanagement

Satus quo & Ziele Ökotoxikologie & Umweltbewertung

Ökotoxikologie: Schadstoffe haben negative Effekte auf den Menschen & die Umwelt (natürliche Mechanismen sind „überfordert“)
→ EC_{50}, NOEC, LOEC,…

- Wie messen wir Verbesserungen?
- Systemische Bewertungsmethoden:
  - **„Whole System Thinking“**
  - **Life Cycle Assessment**
  - **EcoDesign**
  - Technikfolgeabschätzung
  - UVPs, UM,…
- Ökotoxikologie zu wenig beachtet

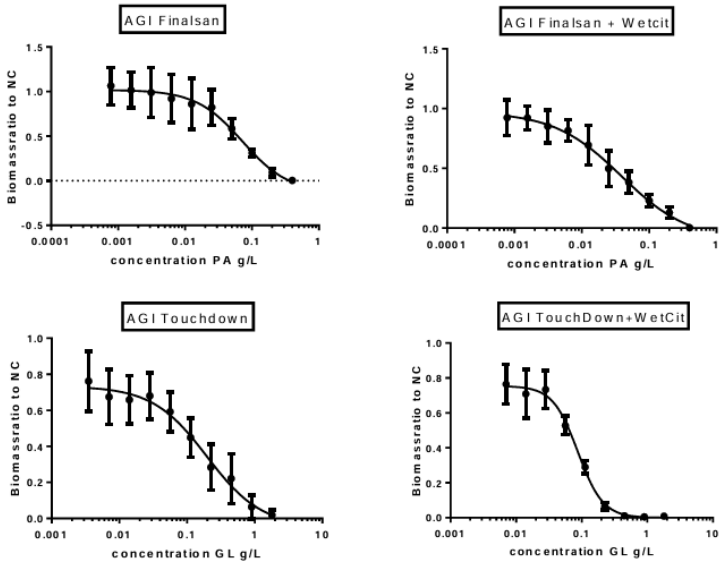
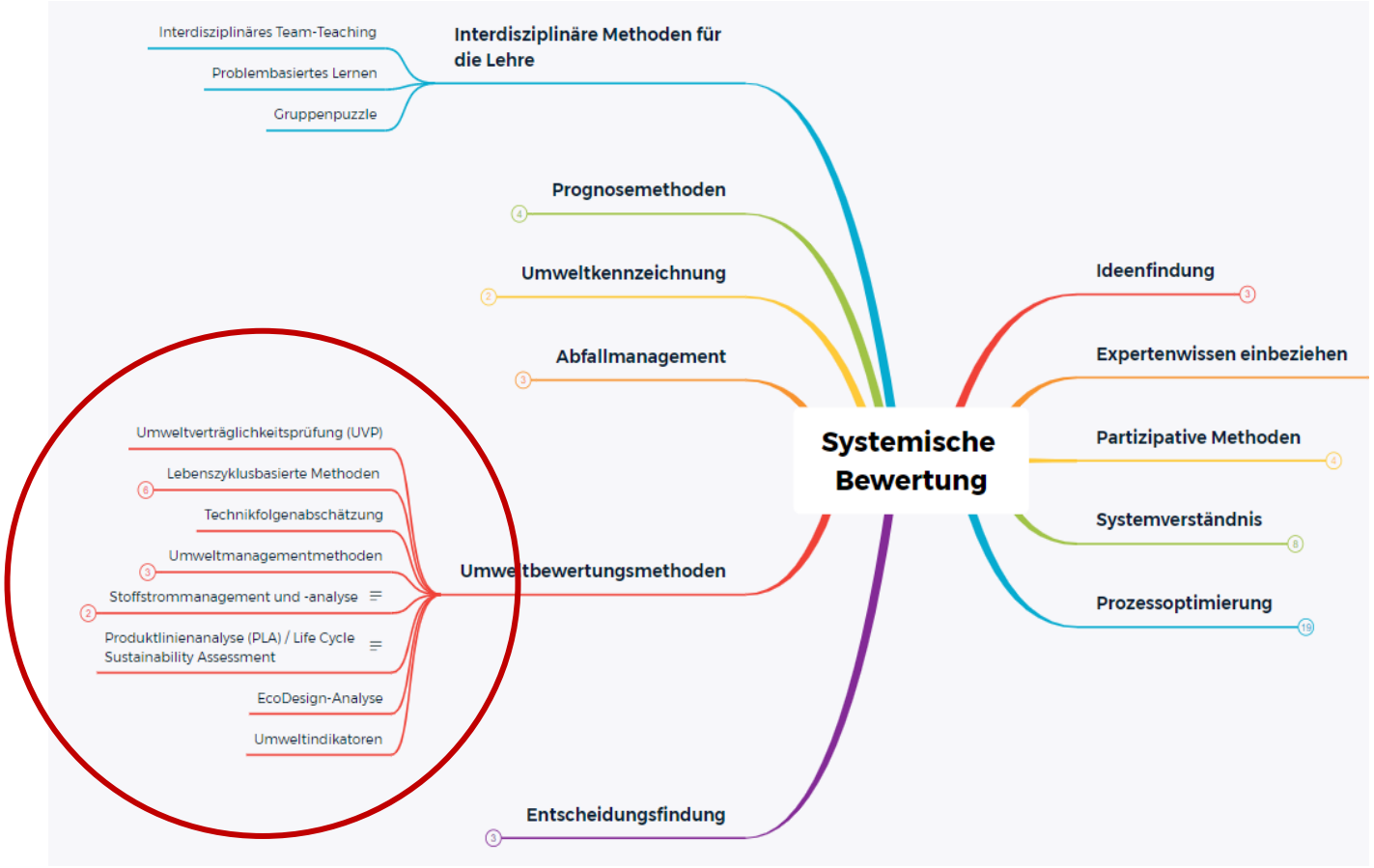


Figure: Dose-response curve AGI Test (*R. subcapitata)* by the addition of Touchdown® Quattro and biohelp Finalsan® Plus. Comparison by the addition of Wetcit®

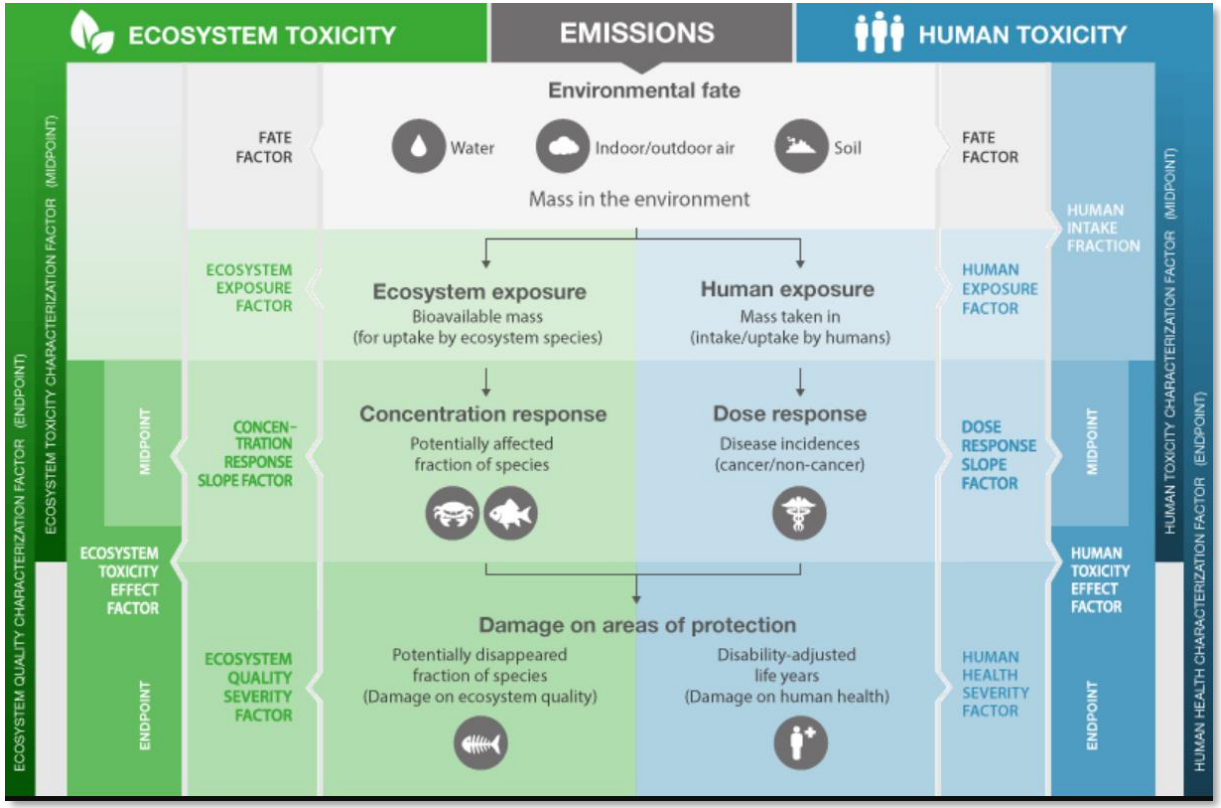
Systemische Bewertungsmethoden für Technik und Umweltmanagement



Systemische Bewertungsmethoden für Technik und Umweltmanagement

USEtox is a **scientific consensus** model endorsed by UNEP's Life Cycle Initiative for characterizing human and ecotoxicological **impacts of chemicals**. Main output is a database of **characterization factors** including fate, exposure, and effect parameters.

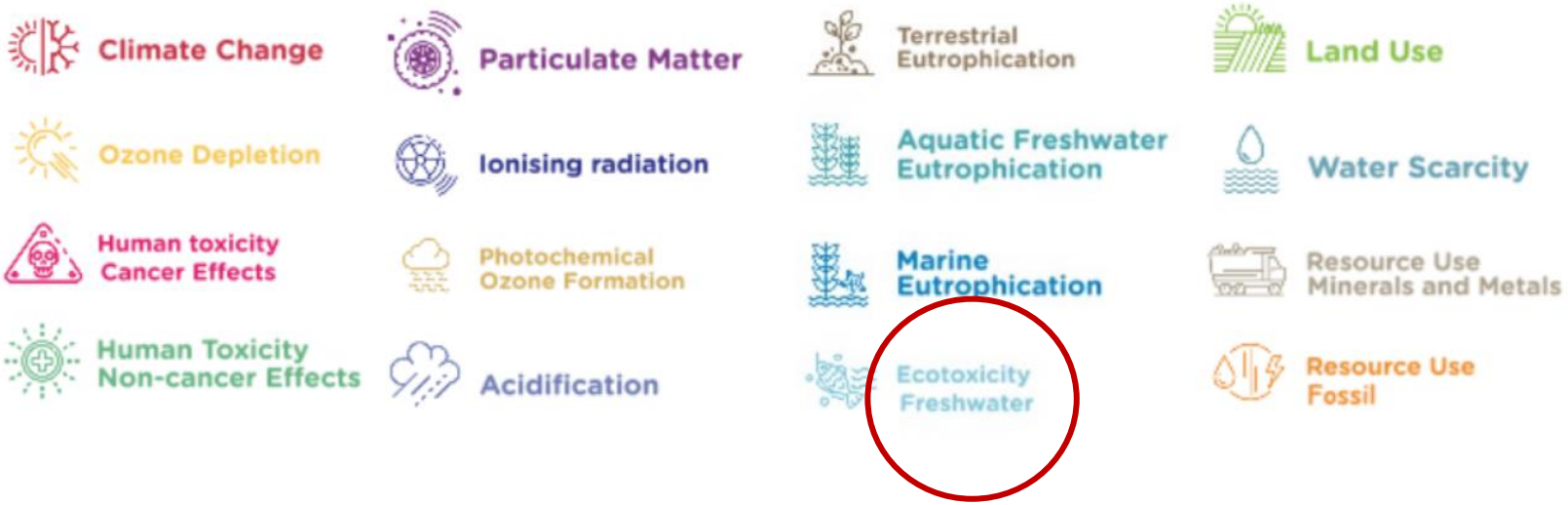
https://usetox.org/



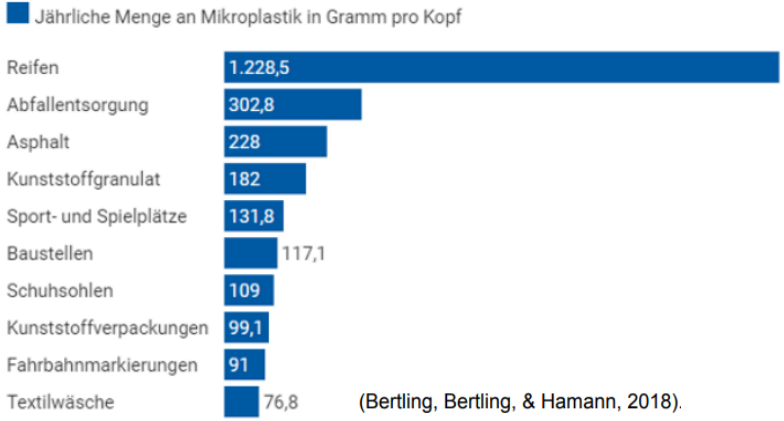
Systemische Bewertungsmethoden für Technik und Umweltmanagement

Impact categories using the EU's Product Environmental Footprint

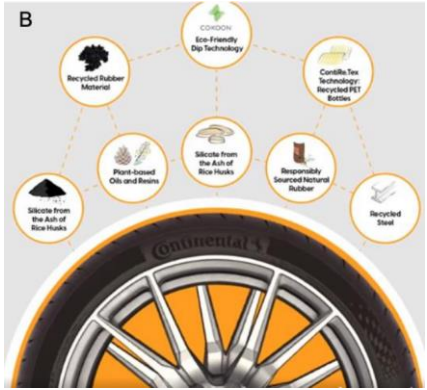
Quelle: Andreasi Bassi, et al. 2023



Case study Auto-/Fahrradreifen



(Bertling, Bertling, & Hamann, 2018).



1) environmental footprint?
2) toxicity?
3) biodegradability?

TARAXAGUM

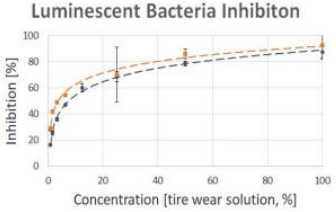
Tire partly based on dandelions as a more sustainable material

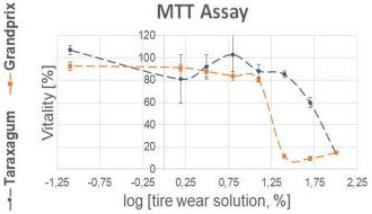
GRANDPRIX

Tire based on conventional materials

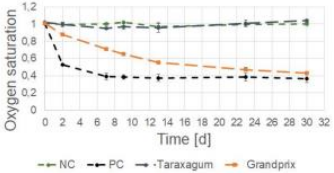
Continental Tires Middle East, 2023

Risk Assessment





- Similar toxicity for Taraxagum and conventional tires. LC50: Taraxagum 9.1%, Grand Prix 7.6%.
- Grand Prix leachate more cytotoxic to MG-63 cells, Taraxagum less so. LC50: Taraxagum 88%, Grand Prix 14%.



- Biodegradability Comparison: Grand Prix leachate biodegradable; Taraxagum not.
- FET Test: Taraxagum (left picture): Minimal embryo lethality. Grand Prix (right picture): Developmental issues, lower hatching at high concentrations.

Mikroplastik als Umweltrisiko, Head: E. Simböck
T. Förster, C. Gebert, M. Feigl

Case study Plastikfolie

- Sind „Bioplastics“ eine Alternative zu konventionellen Polymeren?
- Wie verläuft der Abbau? Oft langsam und unvollständig…
- Gibt es negative Effekte wie oxidativer Stress, endokrine Disruption und inhibierte Proliferation durch Plastikpartikel bzw. Additive?

H. Aghakhanlou, A. Krenauer, J. Berger, S. Ferlin

1. Molecular composition (IR Spectromentry and LC-GC-FID)

- Both films are composed of Polyethylene (PE) (data not shown)
- Extraction experiments with different solvents indicate possible leakage of Mineral Oil Hydrocarbons(MOH) into food (Fig 1)

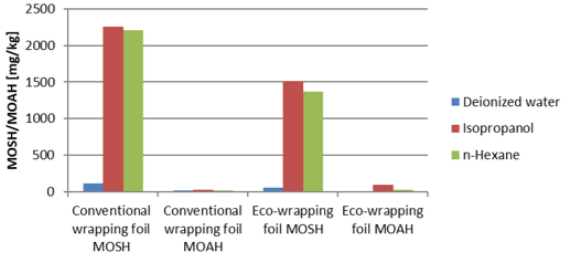


Fig. 1. Comparison of the extraction results of the both films. MOSH stands for Mineral Oil Saturated Hydrocarbons, MOAH for Mineral Oil Aromatic Hydrocarbons.

2. Impact on cells (Luciferase assay and MTT assay of the T47D-Kbluc reporter cell line)

Extracts from wrapping foils (eco variant) showed

- possible estrogenic activity (Fig 2A)
- no effect on cell viability (Fig 2B)

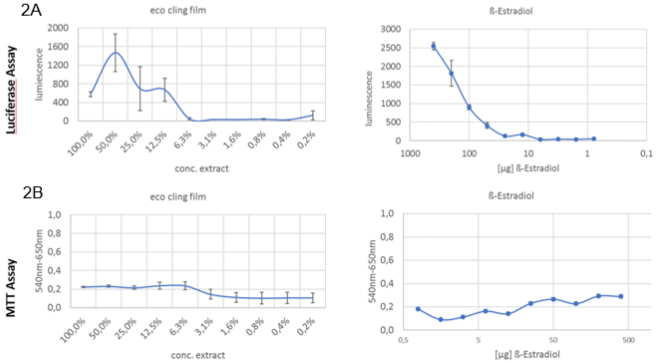


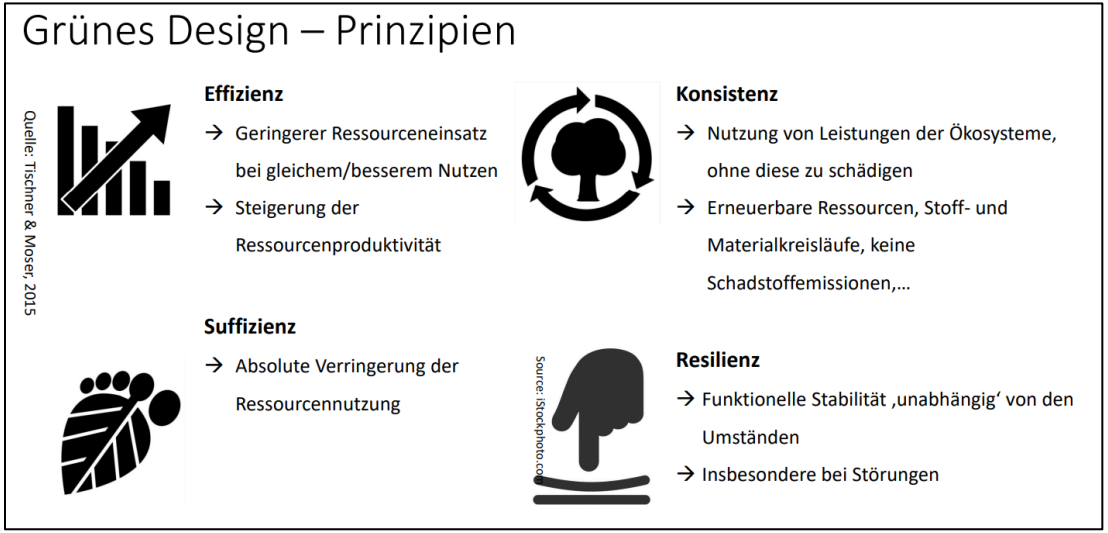
Fig.2. Results of the luciferase and MTT assays

„Safe and Sustainable by Design“

„***Safe and Sustainable by Design***“ bedeutet, dass man beim Design der Produkte mögliche Risiken für die Gesundheit und Umweltbelastungen bereits im Vorhinein bedenkt und berücksichtigt

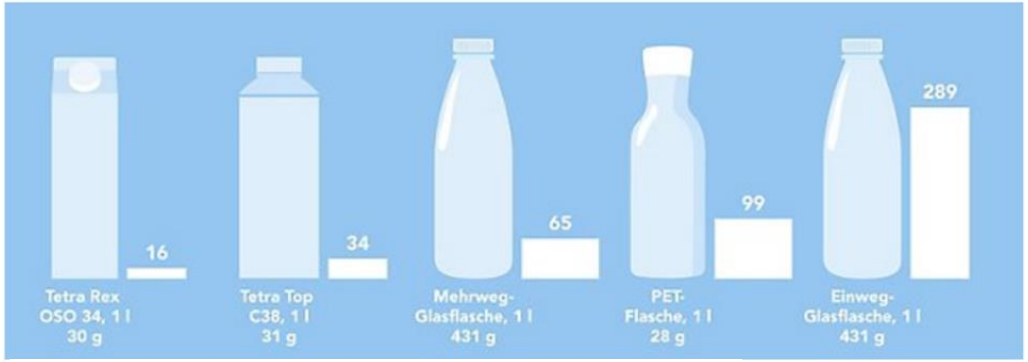
„Projekt Grünes Design“

- Entwicklung eines umweltfreundlichen Haushaltswaschmittels
- Entwicklung eines Shampoos mit geringem Gefahrenpotential
- Entwicklung einer Sonnenmilch mit geringem Gefahrenpotential
- Ökologische Bewertung von Bleichprozessen für Textilien
- Materialoptimierung für Kaffekapsel-Hülsen
- Entwicklung eines Zero-Waste-Konzepts für den Lebensmittelversand
- **Optimierung der Klimawirkung eines Verpackungssystems für Milch**



Case Study Milchverpackung

Optimierung der Klimawirkung eines Verpackungssystems für Milch



ifeu (Institut für Energie- und Umweltforschung Heidelberg), Milch gekühlt, 1000ml, Österreich, 2019.

Unit: kg CO_2e/1000L

Tetra pak layers and their purpose
The Express Tribune, 2014

Georg Pichler, Julia Haller, Katarina Juric, Fabian Mattersberger
Supervising Expert: Lola Charlotte Wenger

Case Study Milchverpackung

"All material and energy inputs and outputs are quantified. This process is divided into different life cycle stages: including manufacture, service life, end-of-life, and disposal"

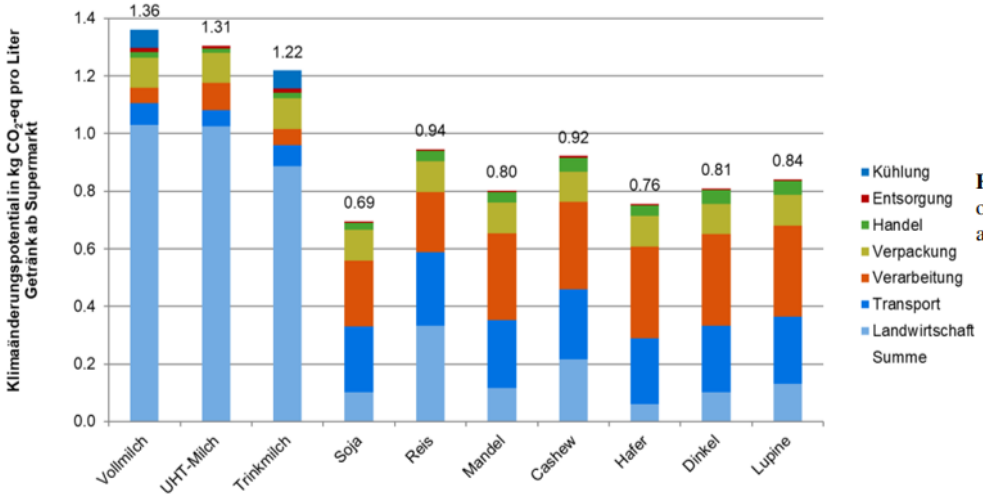


Fig. 5.5 Vergleich der verschiedenen Milchgetränke und nicht angereicherten Drinks für den Treibhauseffekt (kg CO2-eq pro Liter ab Supermarkt, IPCC inklusive zusätzlicher Einflüsse von Flugtransporten (Jungbluth & Meili 2019))

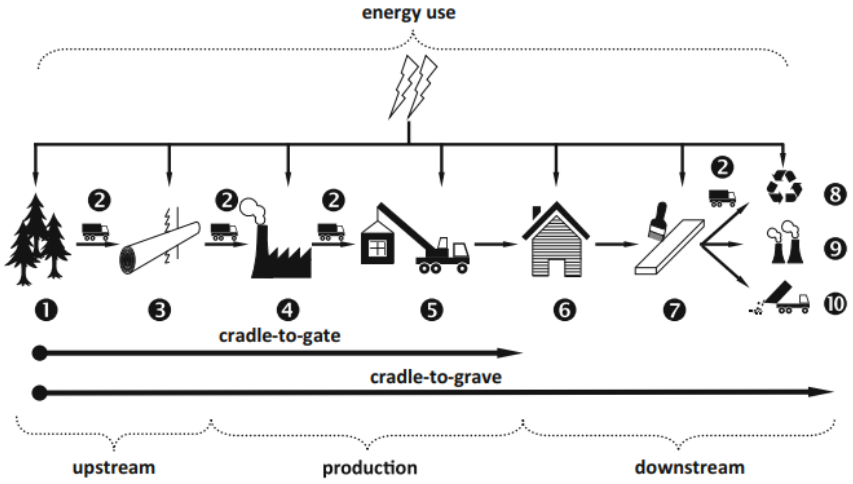
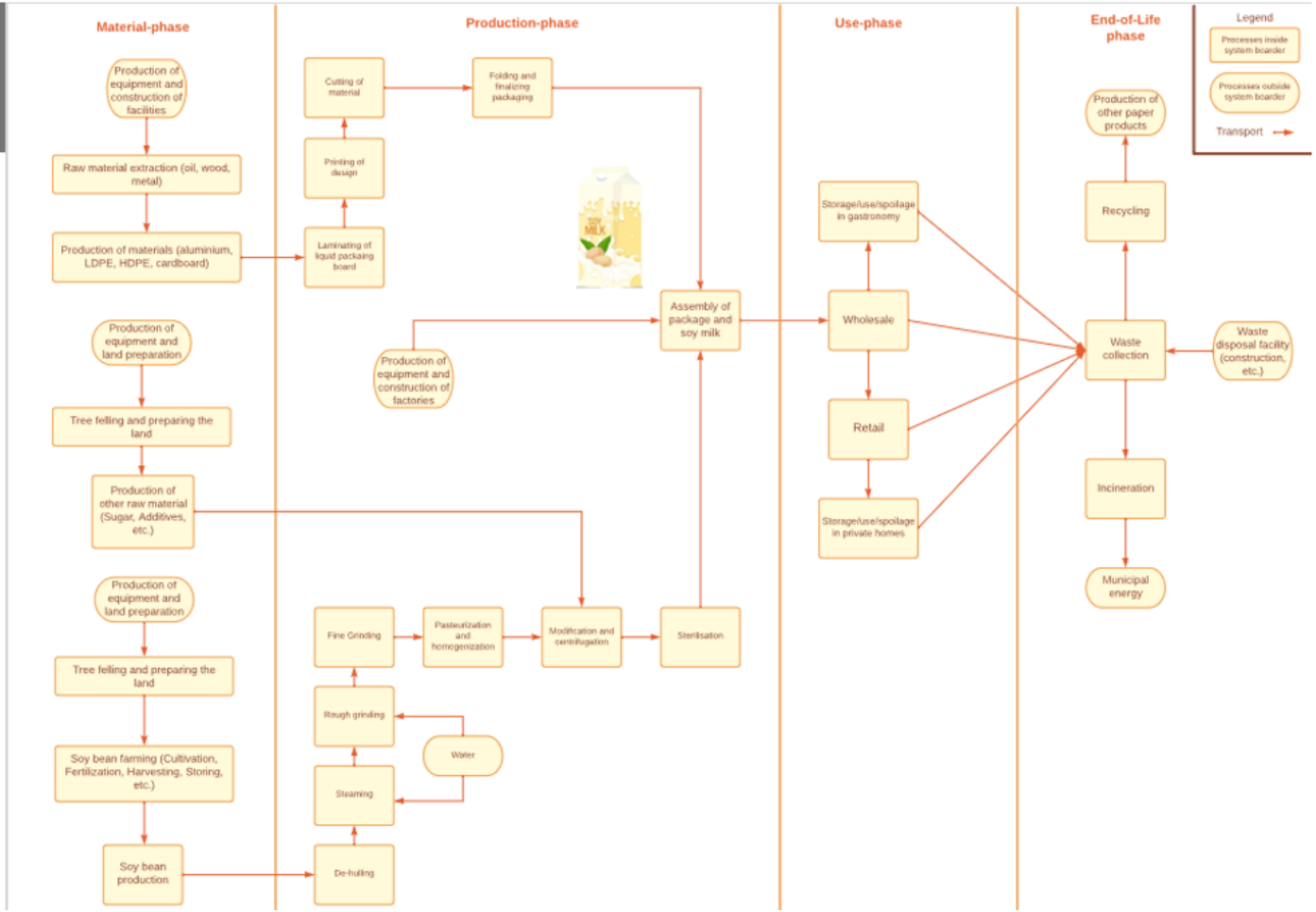


Fig. 2.22 Cradle-to-gate and cradle-to-grave concepts as the LCA system boundaries: ❶ harvest of raw material, ❷ transport, ❸ primary processing, ❹ secondary processing, ❺ construction/assembling, ❻ use phase, ❼ maintenance, ❽ recycling/reuse, ❾ energy generation, ❿ landfilling

https://link.springer.com/chapter/10.1007/978-981-13-3747-5_2

System card

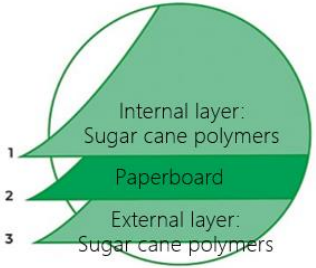

Material-phase
Production-phase
Use-phase
End-of-Life phase
Legend
Processes inside system boarder
Processes outside system boarder
Transport
Production of equipment and construction of facilities
Raw material extraction (oil, wood, metal)
Production of materials (aluminium, LDPE, HDPE, cardboard)
Production of equipment and land preparation
Tree felling and preparing the land
Production of other raw material (Sugar, Additives, etc.)
Production of equipment and land preparation
Tree felling and preparing the land
Soy bean farming (Cultivation, Fertilization, Harvesting, Storing, etc.)
Soy bean production
Cutting of material
Folding and finalizing packaging
Printing of design
Laminating of liquid packaing board
Production of equipment and construction of factories
Assembly of package and soy milk
Fine Grinding
Pasteurization and homogenization
Modification and centrifugation
Sterilisation
Rough grinding
Water
Steaming
De-hulling
Storage/use/spoilage in gastronomy
Wholesale
Retail
Storage/use/spoilage in private homes
Production of other paper products
Recycling
Waste collection
Waste disposal facility (construction, etc.)
Incineration
Municipal energy

Case Study Milchverpackung

- Tetrapack design
- Downsizing (Konzentrat)
- Swich to isolate (Isolat)
- Reducing/replacing single use packaging with refill stations in the supermarket
- Make your own Soymilk

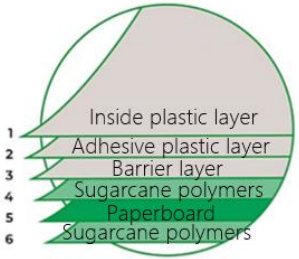
Tetra Rex

- Combination of paperboard and sugarcane-based plastics.
- Reduce of the use of fossil-based materials, (reducing CO_2 emissions by 35%).



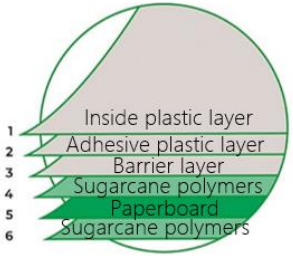
Tetra Brick Edge

- Made of 80% renewable resources.
- The worlds first aseptic carton package.



Tetra Brick Base

- Paper based straw.
- Increased paper content.



©: https://www.tetrapak.com/de

Wie kann Technologie helfen? Können Kunststoffe, Textilien und Chemikalien überhaupt recycled werden und wie? Technologische Lösungen

- Startups
- Etablierte Firmen
- Innovation
- Behörden

Acticell

BLUE PLANET ECOSYSTEMS
Turning sunlight into seafood™

GreenTec Campus

alchemia nova
institute for circular economy & nature-based solutions

wastics

TerraNaste

Bundesministerium
Klimaschutz, Umwelt,
Energie, Mobilität,
Innovation und Technologie

brantner green solutions

Saubermacher

ENERGIEPARK

umweltbundesamt

Interdisziplinäres Arbeiten

Crossdepartmental Workshop

Die Kompetenzlandkarte wächst

- Chemical Engineering & Ecotoxicology
- Resilient Energy Systems
- Human Factors & Sports Engineering
- Medical Engineering & eHealth
- Social Skills
- Economy – Law
- Applied Mathematics and Statistics

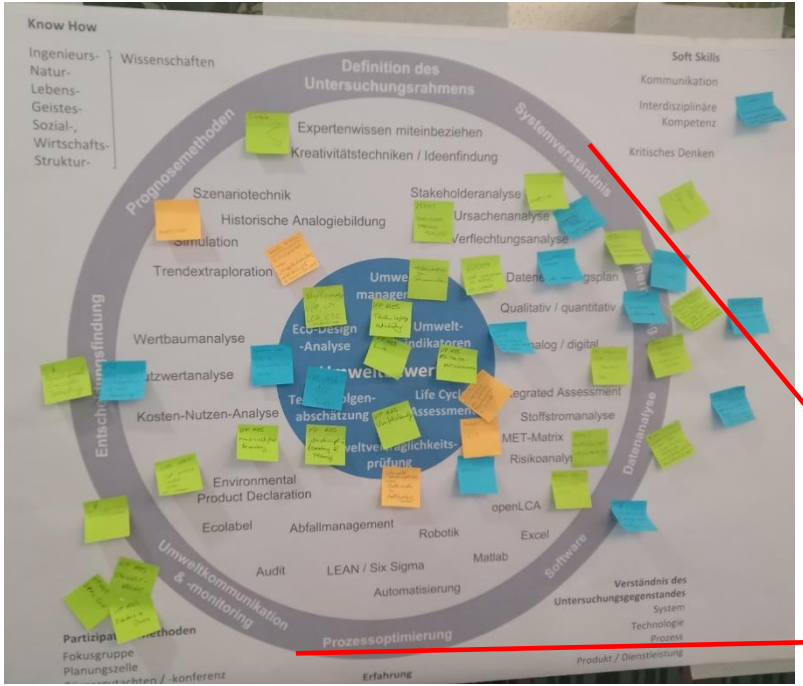
Interdisziplinäre Fachkompetenz

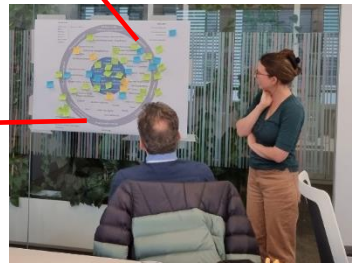
Sozialkompetenz

Personale Kompetenz

Rechtliche Rahmenbedingungen

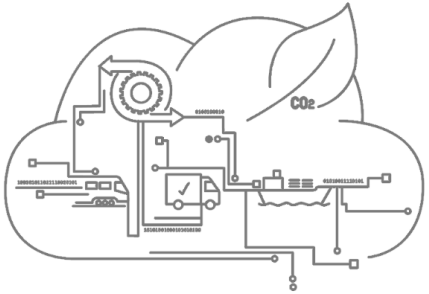
Interest | **Expertise** | **New ideas**





Masterstudiengang Ökotoxikologie & Umweltmanagement
Fakultät Life Science Engineering

Mag. Dr. **Elisabeth Simböck**, Head competence team, City of Vienna (MA23) - Microplastics and nanoparticles
Katharina Wießner, MSc, Microplastics and nanoparticles
Mag. Dr. **Thomas Machacek-Link**, Head competence team, City of Vienna (MA23), & Microplastics and nanoparticles
Linda Prähäuser, BSc, MSc, Microplastics and nanoparticles
Dr. **Ariane Giesriegl**, MSc. Microplastics and nanoparticles
DI **Ursula Knaack**, MSc, Head competence team, City of Vienna (MA23) - Systemic Evaluation Methods in Environmental Management
DI Dr. **Barbara Gepp**, Head of Competence Center Chemical Engineering & Ecotoxicology
FH-Prof. Mag. Dr. **Martina Ortbauer**, Study Porgramme Director Ecotoxicology & Environmental Management



TECHNIKUM WIEN ACADEMY

ESG-MANAGER*IN (ENVIRONMENT, SOCIAL, GOVERNANCE)

EXPERT PROGRAM | PRAXISSEMINARE

Bündnis NACHHALTIGE HOCHSCHULEN