

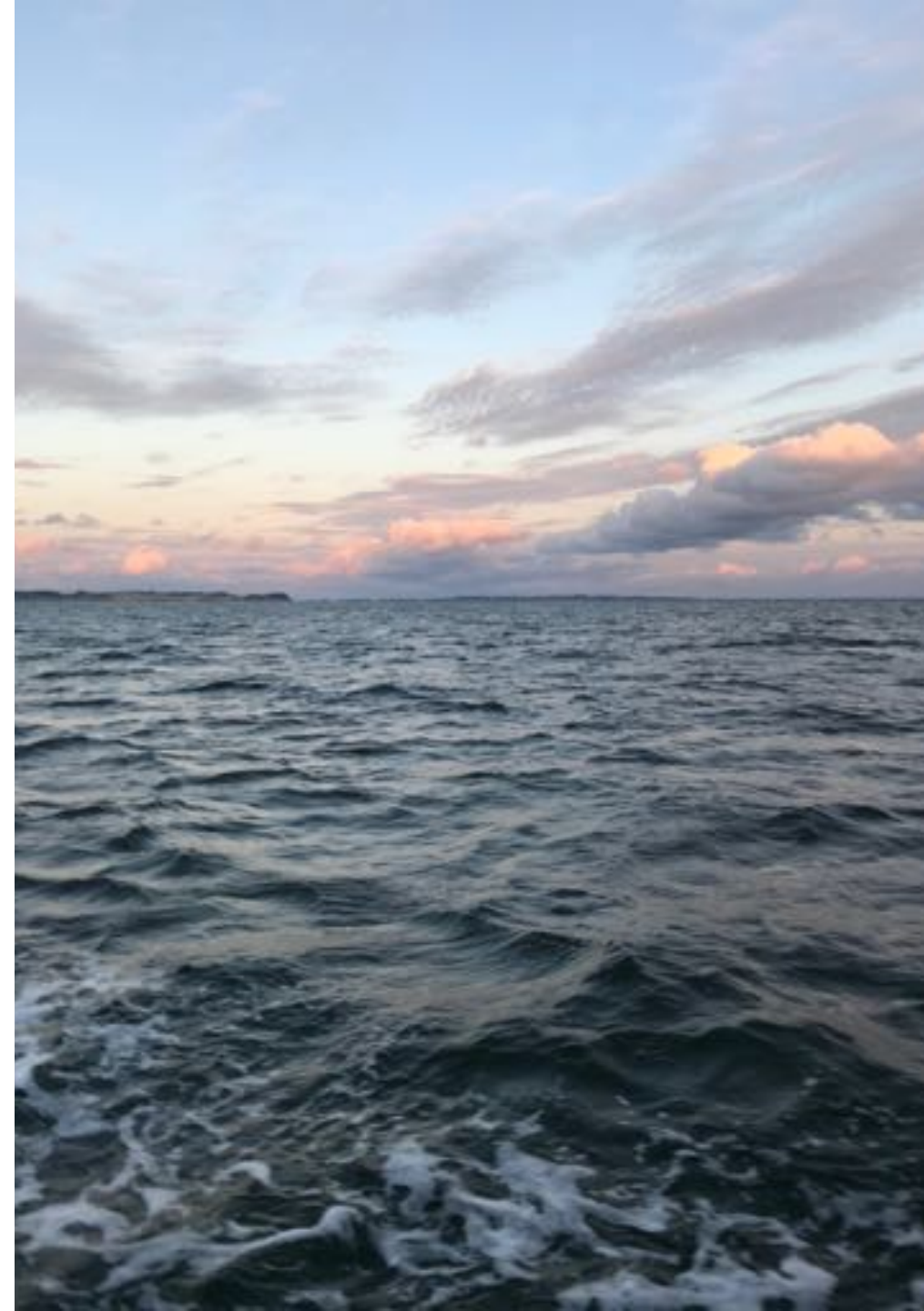
Life Cycle Assessment (LCA) to support design processes and improve environmental performance

MASSIMO PIZZOL, 13 March 2023, online
Digital product pass & LCA Sustainability network
meeting



Today

- Who we are and our work with LCA
- Shortest possible intro on LCA
- Life cycle thinking of sound appliances
- Use and abuse of LCA
- Learn LCA from us



**WHO WE ARE AND
OUR WORK WITH LCA**

Massimo Pizzol

Prof.

- Env. Scientists
- 15 more years in LCA
- Prospective assessment of technology
- Uncertainty analysis
- Green and blue bioeconomy
- Teacher

massimo@plan.aau.dk 
[@m_outreach](#) 



AALBORG UNIVERSITY (AAU)

1974 The answer to a regional challenge

- ▶ Regional need for education, growth and employment
- ▶ Approx. 2,100 students and 250 researchers
- ▶ Humanities, social sciences, engineering and natural sciences
- ▶ Business collaboration = basis of AAU's DNA
- ▶ Problem-based, project-organised learning (PBL)

2020 AAU provides "Knowledge for the World"

- ▶ AAU makes up 10% of the Danish sector - measured on revenue
- ▶ 23,400 students and 2,230 researchers/teachers
- ▶ Humanities, Social Science, Engineering and Science, IT and Design and Medicine
- ▶ Education and business collaboration across Denmark
- ▶ The preferred collaboration partner of the Danish business sector
- ▶ Internationally recognised for our problem and project based learning
- ▶ Interdisciplinary focus
- ▶ No. 23 i among the world's best young universities (under 50 yrs) (Times Higher Education 2020)
- ▶ No. 4 among the world's best engineering programmes (MIT report 2018)
- ▶ Best engineering university in Europe and No. 6 in the world (US News 2020 ranking)
- ▶ Largest intake on IT programmes in Denmark (bachelor intake: 25 % of all IT-students in Denmark)



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PLANNING FOR URBAN SUSTAINABILITY



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DESIGN FOR SUSTAINABILITY



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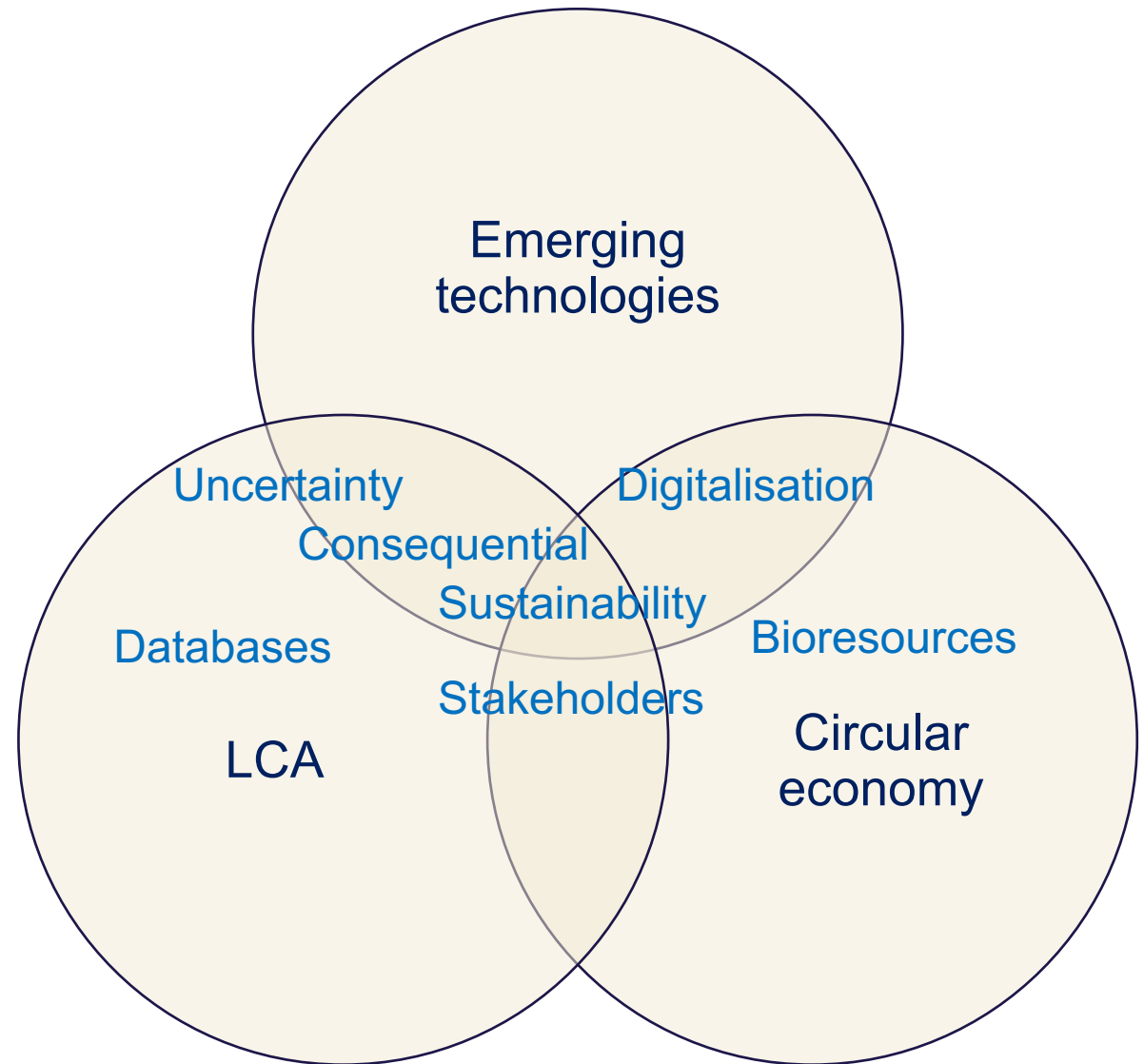


**AAU - The Danish Centre for Environmental Assessment
(DCEA) <https://www.en.dcea.dk/>**



Our LCA research

- ▶ Method development
- ▶ Database development
- ▶ Emerging technologies
- ▶ Circular **bioeconomy**
- ▶ Guidelines analysis



LCA: THE SHORTEST POSSIBLE INTRODUCION

LCA in a nutshell

- ✓ **A model of a product life cycle**
 - ▶ Scope: from raw material extraction to disposal
 - ▶ Input: all material & energy requirement + resource use & emissions
 - ▶ Output: a measure of impact across different categories
- ✓ **A decision support tool to:**
 - ▶ Test improvement scenarios
 - ▶ Make informed decision about reducing impact
 - ▶ Avoid burden shifting
 - ▶ Communicate to partners and clients
- ✗ **An objective measure** of impact or an absolute truth



LCA today

- ▶ An established methodology
- ▶ System of data, databases, and software and companies who do all those
- ▶ System of guidelines and requirements (EPD, PEF, ISO...)
- ▶ A tool widely used in industry and research alike
- ▶ The subject of continuous research



Chapter 2

The Climate Impact of the Usage of Headphones and Headsets



Herrmann, T., Zimmerer, A., Lang-Koetz, C., & Woidasky, J. (2023). The Climate Impact of the Usage of Headphones and Headsets. In F. Hesser, I. Kral, G. Obersteiner, S. Hörtenhuber, M. Kühmaier, V. Zeller, & L. Schebek (Eds.), *Progress in Life Cycle Assessment 2021* (pp. 7–22). Springer International Publishing. https://doi.org/10.1007/978-3-031-29294-1_2

Tayla Herrmann, Anna Zimmerer, Claus Lang-Koetz, and Jörg Woidasky

Abstract Based on disassembly studies, a life cycle assessment of the climate impact of the wireless over-ear headphone model Jabra Evolve2 85 (without charging station) is conducted regarding the life cycle phases of manufacturing, packaging, distribution, use and disposal. The total weight of all components is 280.7 g. The materials can be categorized into polymers (61.7%), metals (20.9%), circuit boards (4.8%), Li-ion battery (4.6%), foam (3.5%), cables (3.0%) and unidentifiable polymers (1.7%). The functional unit is defined as the wireless audio transmission through a stereo headphone over its lifetime. The lifecycle assessment results in a global warming potential of 12.17 kg CO₂-Eq with a contribution of the manufacturing phase of 81.2%, based on an assumed lifetime of 2,600 using hours. In the context of a sensitivity analysis, a repair scenario of a battery replacement of the over-ear headset is modelled. Assuming a doubled lifetime, the global warming potential per hour is reduced from 4.7 g CO₂-Eq/h to 2.4 g CO₂-Eq/h.

Keywords LCA · Headphones · Dismantling · Life cycle data inventory

A typical LCA

- Define what should the product do
- Calculate impacts via an indicator
- Identify hot spots
- Assumptions
- Scenarios, and more assumptions

Takeaways:

- manufacturing main contributor,
- lifetime extension halves impacts.

Real-world example

Herrmann, T., Zimmerer, A., Lang-Koetz, C., & Woidasky, J. (2023). The Climate Impact of the Usage of Headphones and Headsets. In F. Hesser, I. Kral, G. Obersteiner, S. Hörtenhuber, M. Kühmaier, V. Zeller, & L. Schebek (Eds.), *Progress in Life Cycle Assessment 2021* (pp. 7–22). Springer International Publishing. https://doi.org/10.1007/978-3-031-29294-1_2

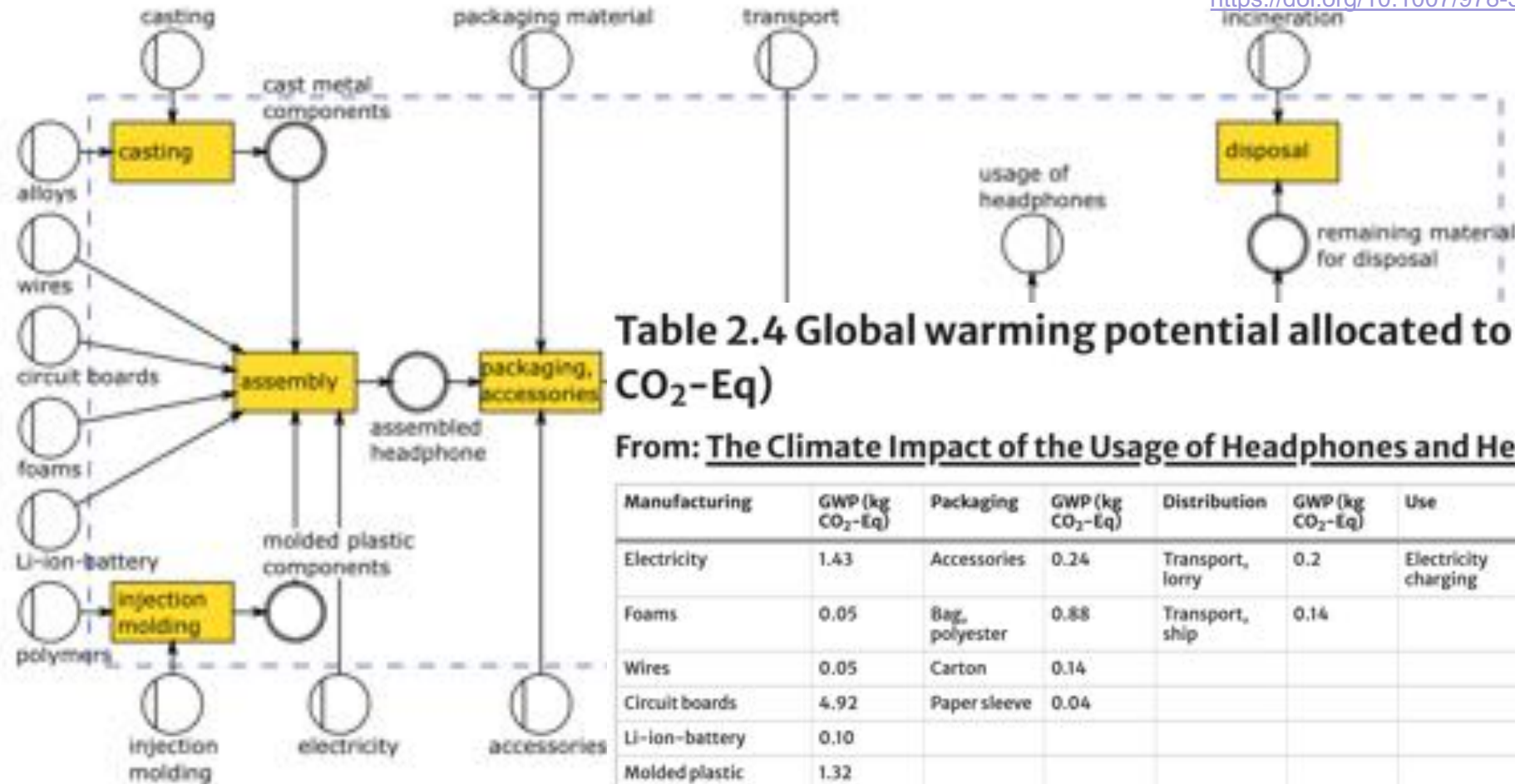


Table 2.4 Global warming potential allocated to life cycle stages (kg CO₂-Eq)

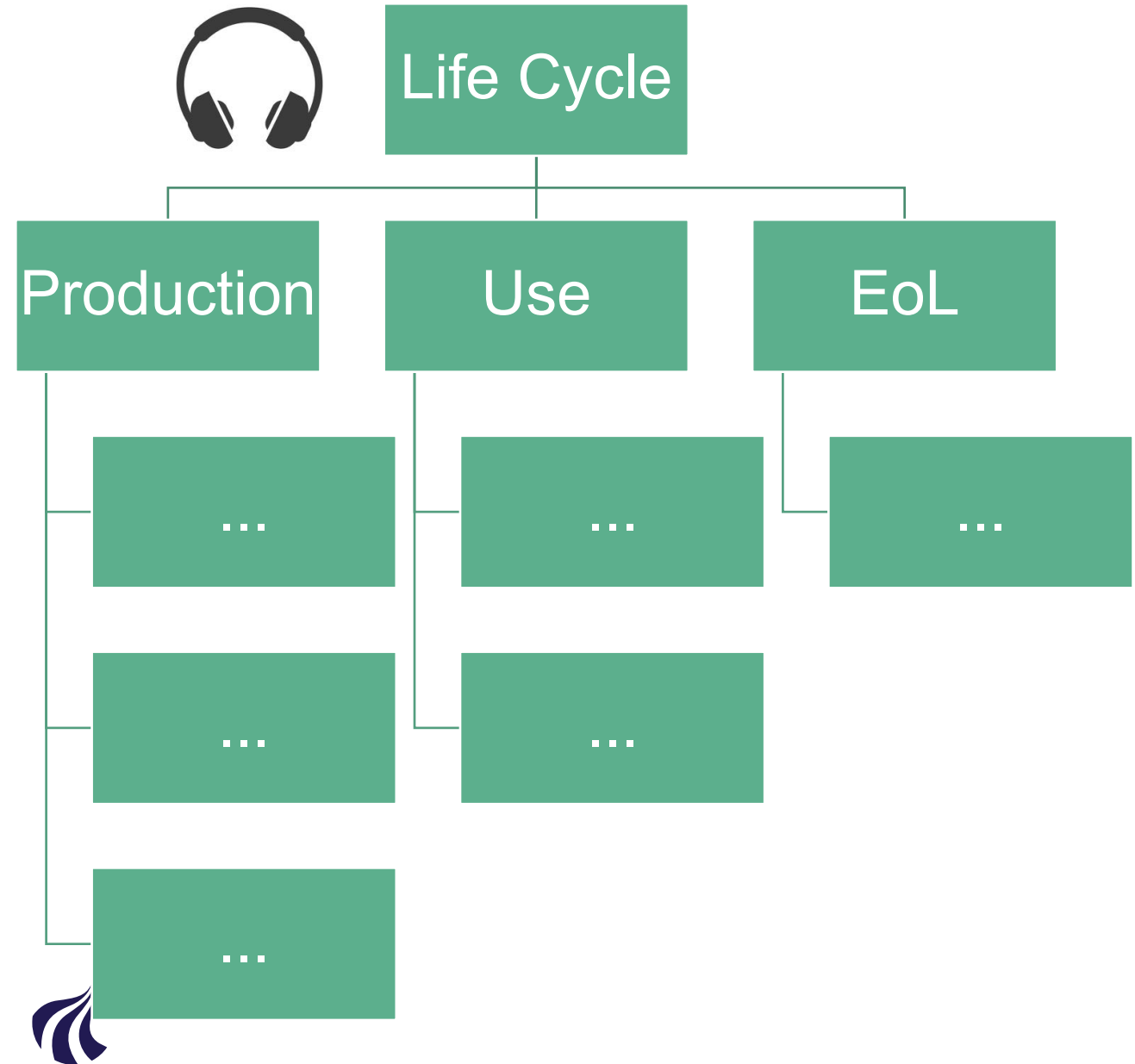
From: The Climate Impact of the Usage of Headphones and Headsets

Manufacturing	GWP (kg CO ₂ -Eq)	Packaging	GWP (kg CO ₂ -Eq)	Distribution	GWP (kg CO ₂ -Eq)	Use	GWP (kg CO ₂ -Eq)	End-of-life	GWP (kg CO ₂ -Eq)
Electricity	1.43	Accessories	0.24	Transport, lorry	0.2	Electricity charging	0.18	Incineration	0.42
Foams	0.05	Bag, polyester	0.88	Transport, ship	0.14			Pyrometallurgic treatment	0.02
Wires	0.05	Carton	0.14						
Circuit boards	4.92	Paper sleeve	0.04						
Li-ion-battery	0.10								
Molded plastic components	1.32								
Cast metal components	2.02								
Total	9.88	Total	1.33	Total	0.34	Total	0.18	Total	0.44

**LIFE CYCLE THINKING OF SOUND
APPLIANCES**

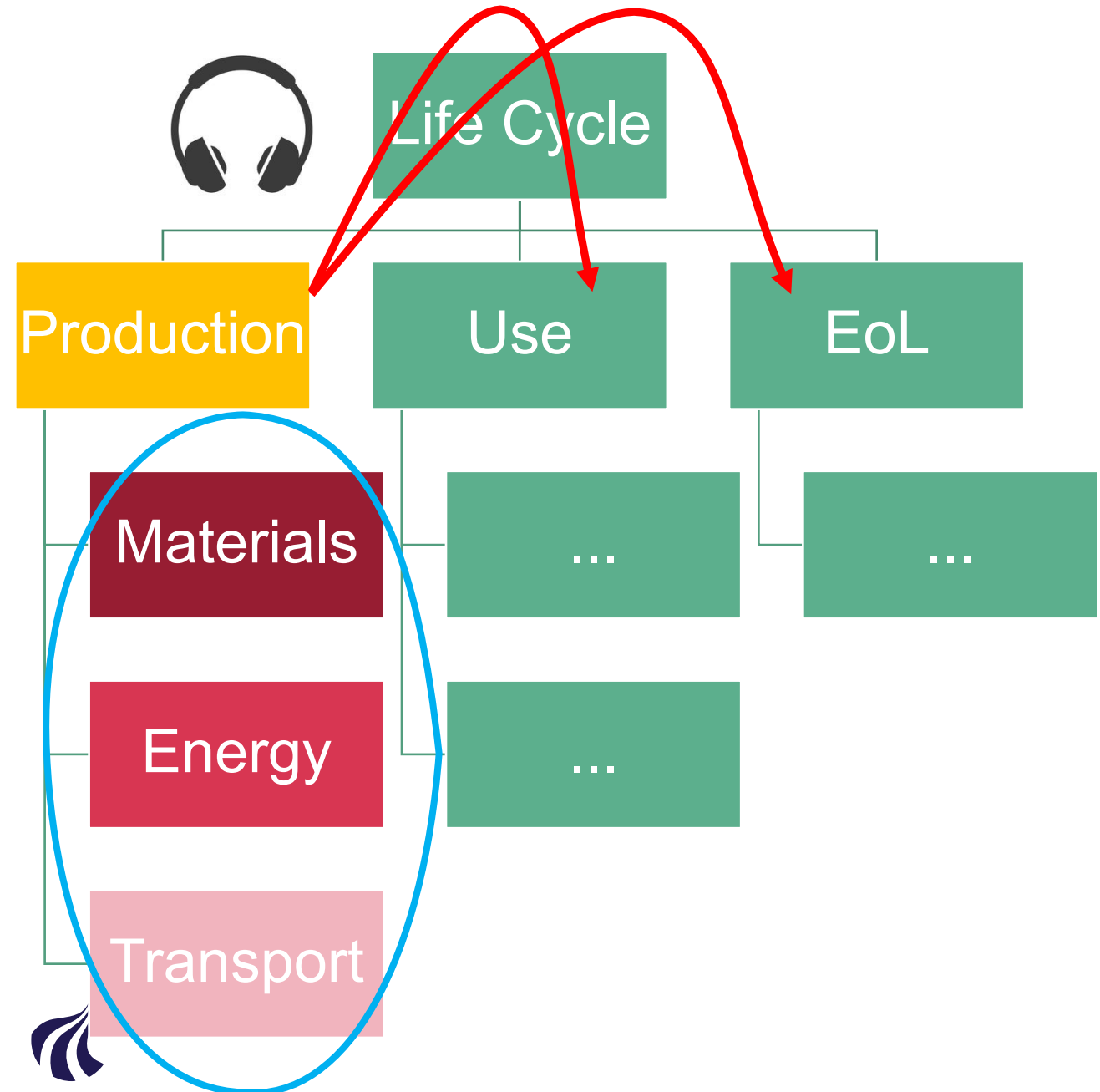
Sound appliances

- ▶ From a LCA perspective, not different from other electric appliances such as TVs, refrigerators, washing machines, or computers
- ▶ Roughly three stages are important:
 - **Production**
 - **Use**
 - **End-of-life**



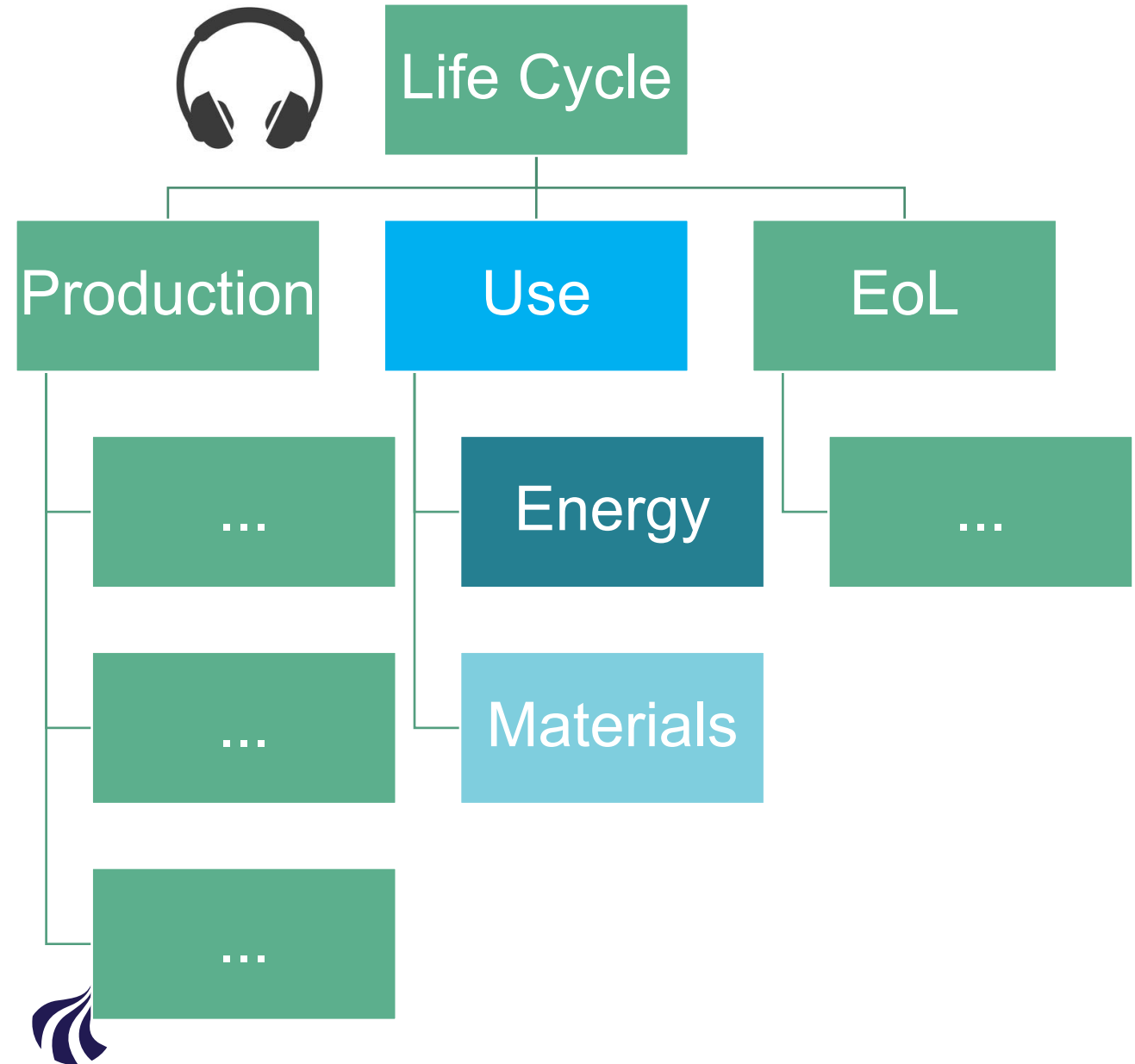
Production

- ▶ Most important in design perspective
- ▶ Choices made here cascade in later stages
- ▶ Size of impact:
 - Materials > Energy > Transport



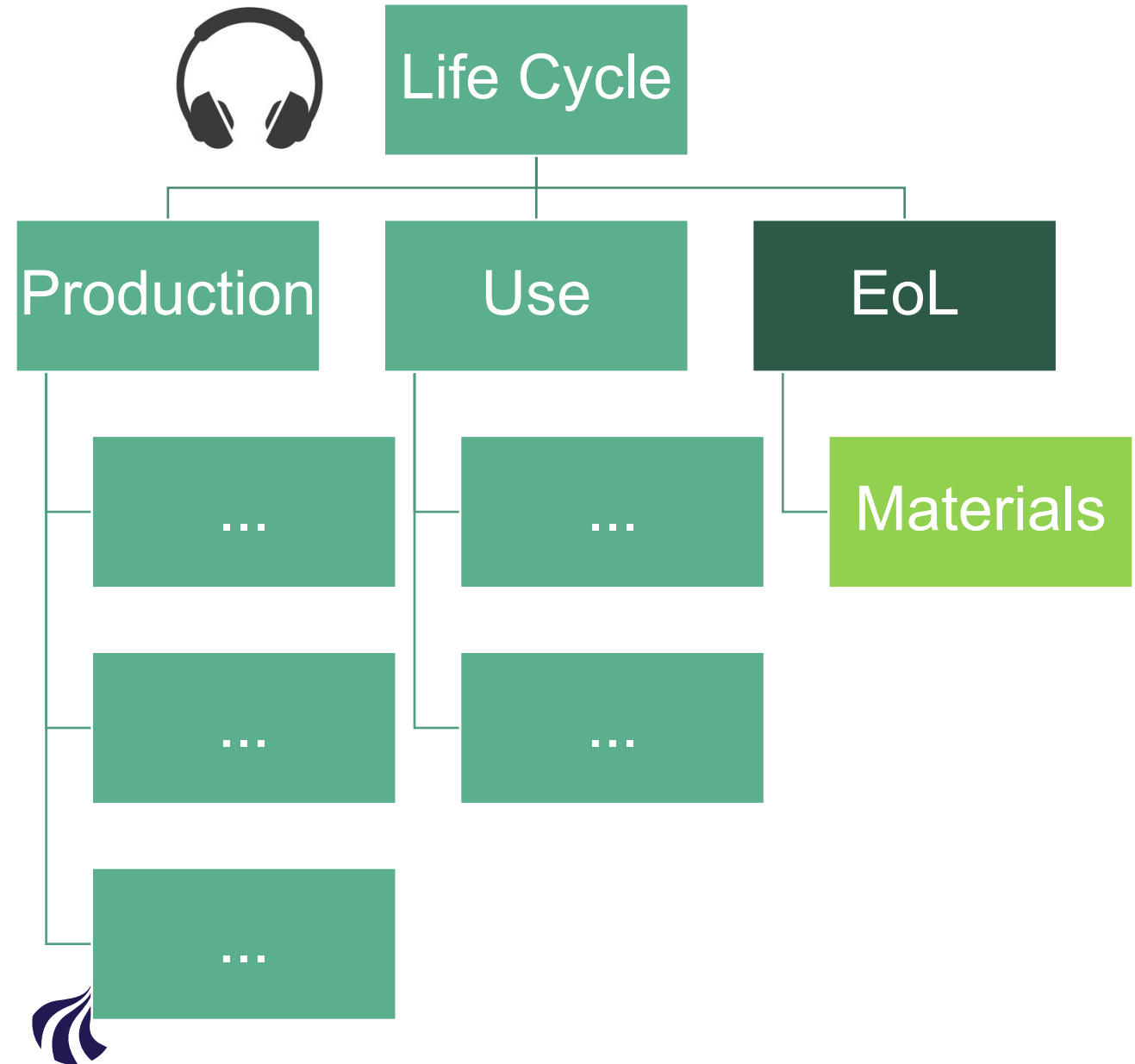
Use

- ▶ Low influence by producer
- ▶ High variability due to **user behaviour**
- ▶ Can be **hot-spot** over life cycle **due to energy use**
- ▶ Materials only relevant for maintenance (more important with repair! circular economy)
- ▶ **Lifetime** is key parameter (link back to production)



End of Life

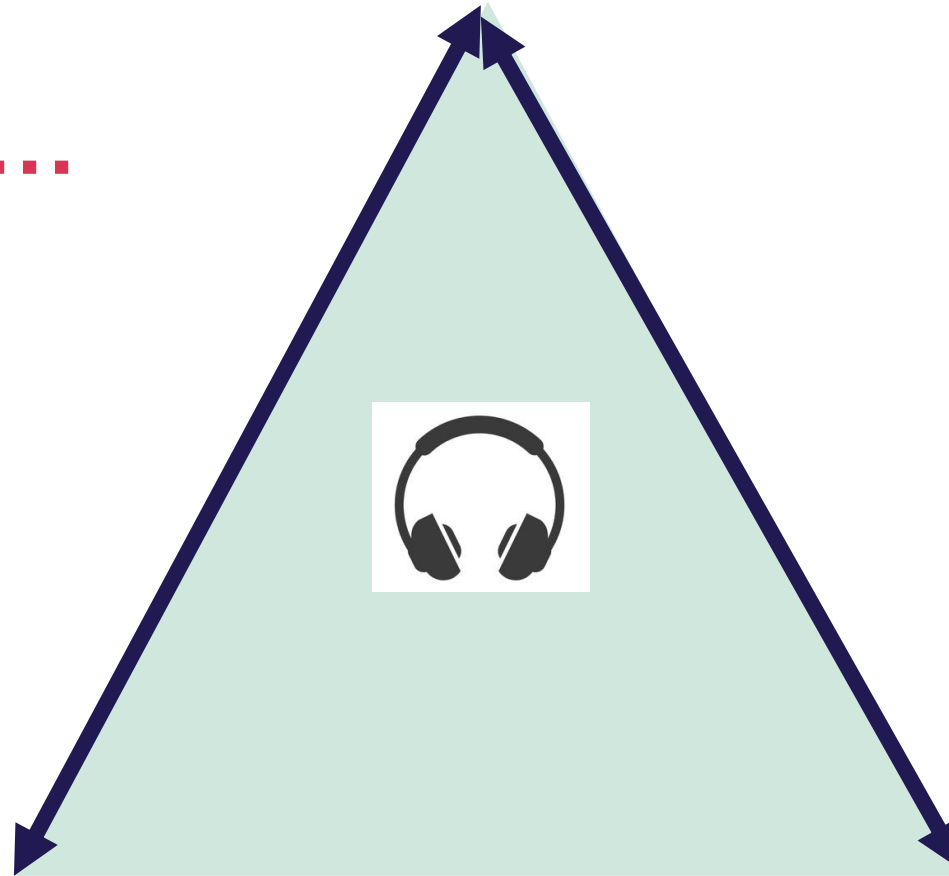
- ▶ Uncertain and out of producer control
- ▶ High spatial and temporal variability
(Waste management in China in 10y?)
- ▶ **Important for resource recovery**
- ▶ A technical as well as management issue
("recyclable" means nothing unless
waste is first sorted...)



**I want to
change
material...**

Production

**Burden-
shifting**



**Can it be recovered?
(Impact of waste man.
change)**

Use

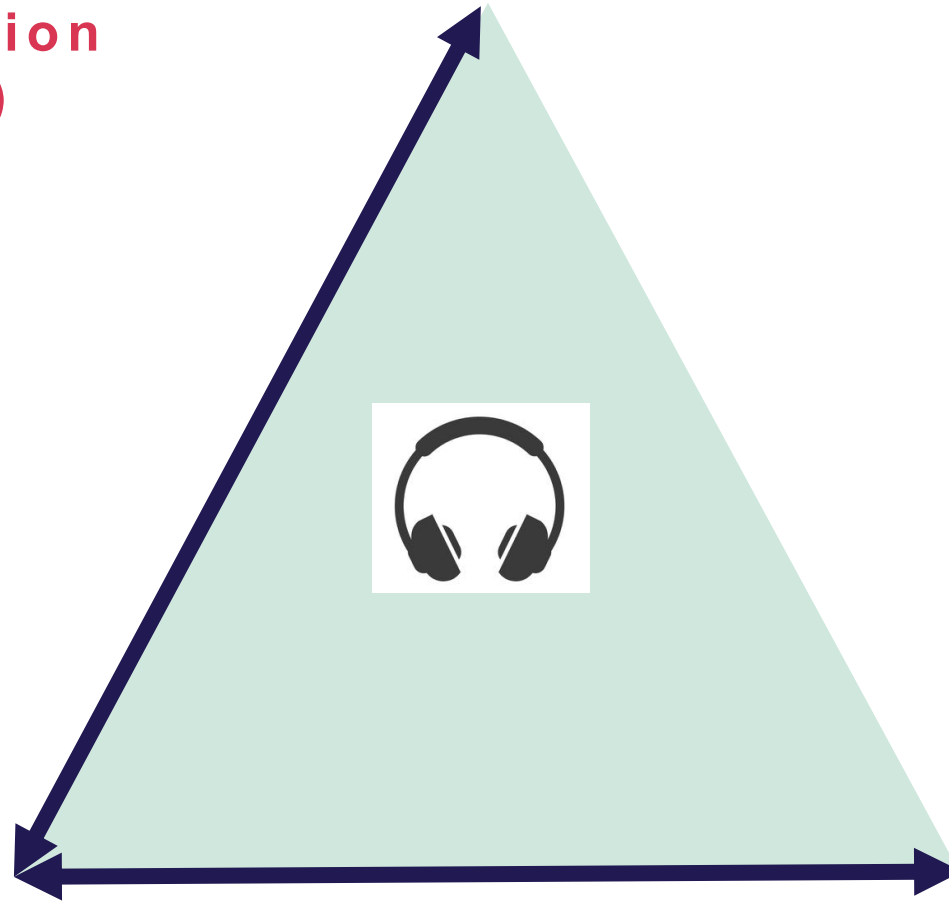
EoL

**Will it last less? (Impact of
lifetime change)**

Will I need more materials? (Impact of production change)

Production

Burden-shifting



Will I have a sorting system in place in the distant future? (Impact of waste man. change)

Use

EoL

I want a more durable product...

**Change in design and components?
(impact of sourcing and energy in manufacturing)**

Production

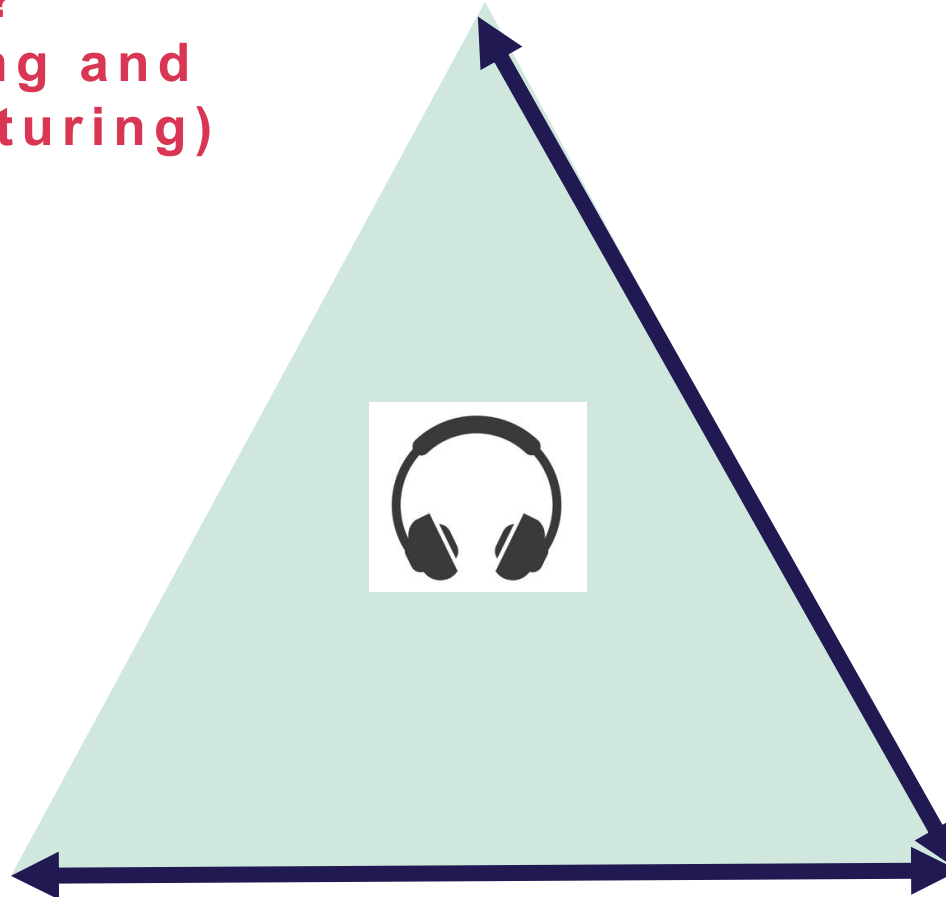
Burden-shifting

I want a product that can be disassembled completely

EoL

Use

Will the user behaviour change? (impact of lifetime change)



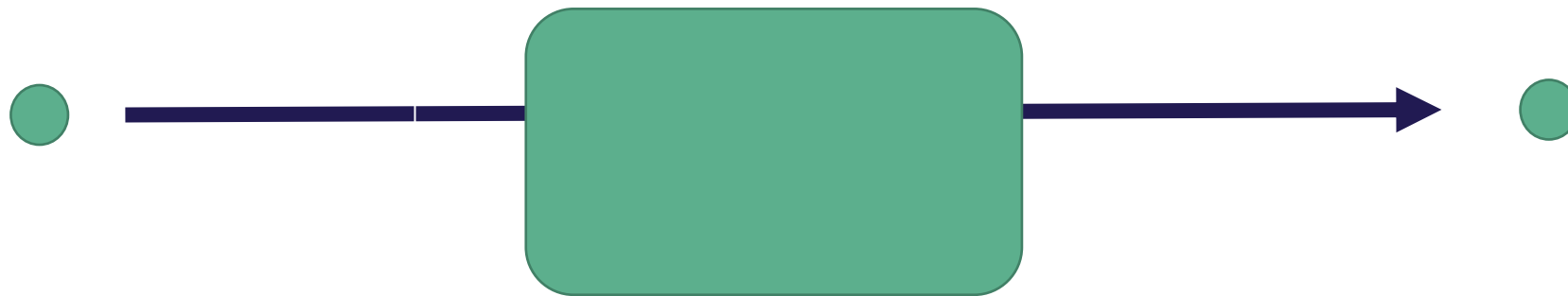
USE AND ABUSE OF LCA MODELS

LCA

Input

Model

Output



Uncertainty, typical questions

- *How sure am I of my LCA results? How wrong can they be?*
- *Is there any data input that might change substantially?*
- *Does the way the model is constructed reflect reality?*
- *Does my study depend on specific conditions?*
- *Did I make any critical assumption or choice in the study?*
- *Am I using old or new data?*
- *How far am I looking into the future?*
- *Is there something I don't know about the subject of my LCA study?*

A paradigm shift

Current paradigm:

Focus on the single LCA numerical result.

Looking for the “right” number.

Narrowing scope.

Uncertainty, what is that?

Decisions first, model later...

A “sound” paradigm:

Focus on assumptions and data ranges.

There is a “cloud” of numbers.

Expanding scope.

We don’t know everything

Model first, decisions later...

Limits of quantification

We can make a lot of LCA models...but can we make good ones?

- Less focus on results, more focus on process
- *There is no 'number-answer' **
- Explorative attitude, embrace the uncertainty space
- Assumption-testing
- Modelling ethics rather than standardisation

New skillset and new mindset

When you can make many LCA simulations...

...focus on the simulations that matter, design the scenarios to support your decisions (*change the critical assumptions to stress-test decisions...*)

When the reality is difficult to describe univocally...

...focus on scenario design via co-creation with stakeholders (*LCA practitioner does not decide alone...*)

Learn LCA from us

LCA course for professionals



SÆRSKILT MODUL

LIVSCYKLUSVURDE- RING (LCA) MED FOKUS PÅ KLIMAAFTRYK



TECH CENTRE FOR CIRCULAR ECONOMY



<https://www.en.tech.aau.dk/research/research-groups/centre-for-circular-economy>

LCA module included 🙌🙌🙌



SUMMER SCHOOL IN APPLIED CIRCULAR ECONOMY

ABOUT The 5 ECTS course builds and strengthens competences in applied circular economy using the **Problem Based Learning** teaching model of learning by doing and reflection. It applies a **hybrid (online + physical) and flipped classroom approach** where materials, readings, videos are provided to the students in advance and the time spent together is used for course activities such as **intensive group work, problem defining and solving applied to real-world cases, practical exercises, and discussions.**

PREREQUISITES The course is interdisciplinary and open to participants of different backgrounds. Basic as well as advanced elements of the circular economy theories and practice will be covered.

MODULE 1. CIRCULAR ECONOMY, FROM THEORY TO PRACTICE will introduce to different theoretical approaches to circular economy as well as to their respective critiques. The focus will be on discussions on **narrowing, slowing and closing resource flows** - especially on the inner circles of circular economy - and how the potentials for circular improvements are identified. The module includes group-exercises where theories of circular economy are applied to the analysis of a case study.

MODULE 2. CIRCULAR BUSINESS MODELS AND STRATEGIES will explore the diversity in circular business models, especially with focus on the inner circles. The relevance of including new types of actors in these business models is discussed and various real-world case studies are presented to the students. Moreover, generic **principles and strategies are introduced that can be applied in the design and innovation process** to ensure more circular outcomes, i.e. for narrowing, slowing, closing and regenerating resource flows. The module includes group-exercises where a circular business strategy is designed for a specific case study.

MODULE 3. LIFE CYCLE ASSESSMENT OF CIRCULAR BUSINESS STRATEGIES hands-on module to learn LCA for the development and evaluation of circular economy strategies. Covers theoretical elements of LCA, **from life cycle thinking to computational structure of LCA**, and practical elements such as use of LCA software, interpretation, use of results in the development of life cycle management strategies, and communication of results. The module includes group-exercises where LCA is applied to evaluate a circular strategy for a specific case study.

LECTURERS TECHACE guest Prof. Nancy Bocken (Maastricht Univ.), Melanie Jaeger (IBen (BTU Cottbus), Ruth Muggé (TU Delft) **TEOME members** Assoc. Prof. Mette Alberg Møsgaard, Assoc. Prof. Michael Søgaard Jørgensen, Prof. Massimo Pizzol, Assoc. Prof. Louise Møller Haase, Assoc. Prof. Reza Tadayoni, Assoc. Prof. Bent Thomsen, Assoc. Prof. Maria Niero + others...

REGISTRATION via google form 📄

<https://forms.gle/yetMq8oASwnLGwzA9>

DEADLINE APRIL 15th 2024

CONTACT & INFO massimo@plan.aau.dk



The course is organized by the Centre for Circular Economy (TECHCE2) and Technical Doctoral School of IT and Design, at the TECH Faculty, Aalborg University
Date created: 20.02.2024, last updated: 20.02.2024

DATES IN 2024

Online sessions CET

11 June 10:00-12:00

13 June 10:00-12:00

18 June 10:00-12:00

20 June 10:00-12:00

25 June 10:00-12:00

27 June 10:00-12:00

Onsite sessions

in Aalborg, Denmark

4-5-6 September



ATTENDEE / PRICE

PhD students @Danish University / Free

@Maastricht University, BTU Cottbus,

TU Delft / 2.250 DKK (300 EUR)

@ other affiliation / 4.500 DKK (600 EUR)

Academics (postdoc, professor, etc.) /

9.000 DKK (1.200 EUR)

Professionals (consultancy, industry, etc.) /

18.000 DKK (2.400 EUR)

Prices do not cover meals or accommodation

Advanced LCA PhD course



Thank you

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