

63rd LCA Discussion Forum – 30.11.2016

Challenges in LCA modelling of multiple loops for aluminium cans

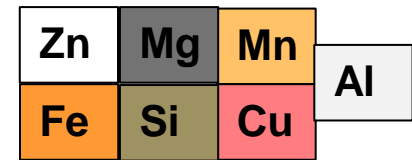
[Monia Niero, Stig I. Olsen](#)

Outline

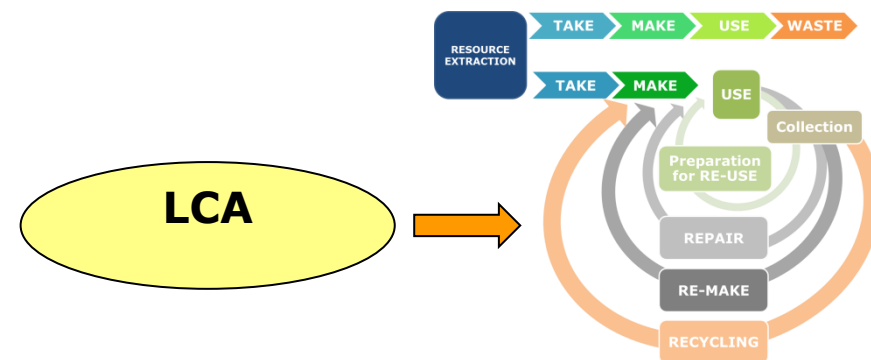
- *Introduction:*
Put the research into context



- *Case study:*
LCA modelling of multiple loops for aluminium cans



- *Perspective:*
How can LCA support the circular economy?



Aim of the project

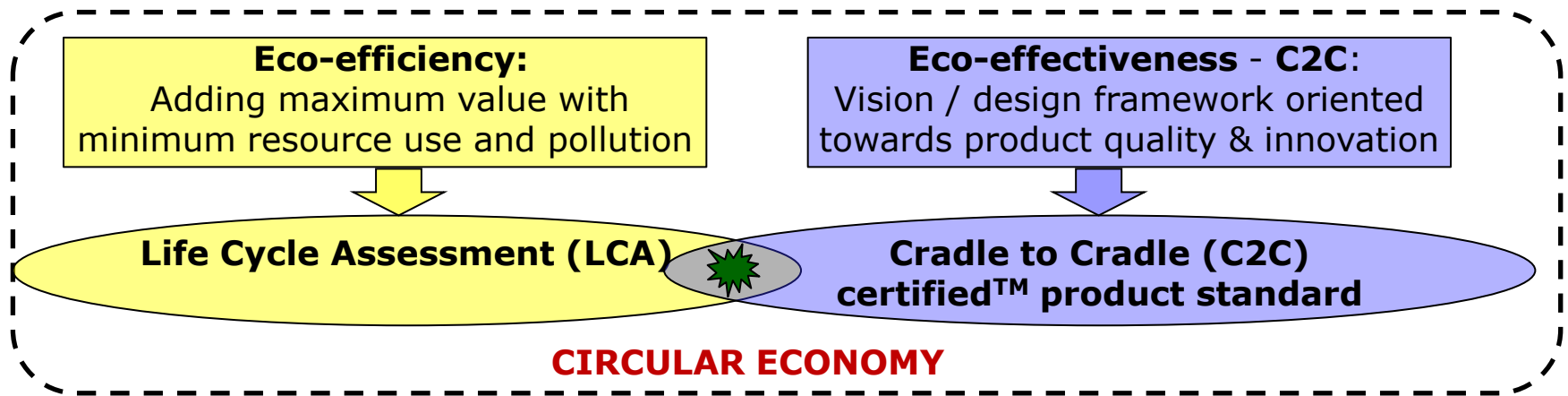
- **Vision:**

Support **Carlsberg** in the development of **environmentally sustainable and innovative** beer packaging solutions



- **Objective:**

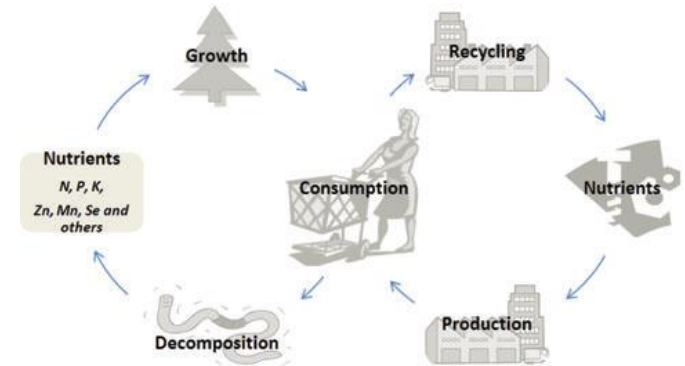
Combine **Life Cycle Assessment (LCA)** and **Cradle to Cradle® (C2C) design framework** towards **continuous loop** packaging systems



How can the C2C vision inspire LCA?

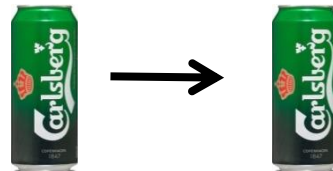
C2C vision aims to generate cyclical, cradle-to-cradle “metabolisms” that enable materials to maintain their status as resources

Braungart et al. (2007)



Bjørn & Hauschild (2013) J Ind Ecol 17(2) 321-332

- C2C supports **continuous material loop** ≠ closed material loop
- From C2C analysis aluminum is a “technical nutrient” = a material suited to remain in a **closed-loop system** maintaining its highest **value** through many product life cycles



Objective of the LCA study

→ To answer the Hamlet dilemma for aluminium cans in a circular economy:
to be or not to be - in a closed product loop?



Implications for functional unit definition

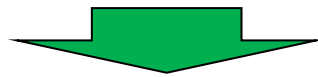
→ “*Traditional*” functional unit (FU): **containment** of 1 hl of beer



BUT a circular economy aims to use **materials in continuous loops** therefore this is not the only function...

From ILCD Handbook, Annex C, p. 351 → an aluminium beverage can:

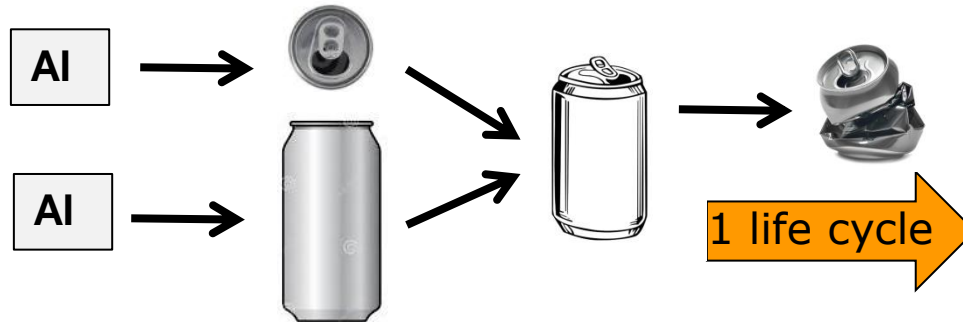
- 1st co-function: to **carry and protect** the beverage it contains
- 2nd co-function: the aluminium scrap (i.e. the end-of-life can) it provides as **secondary resource** for subsequent product systems



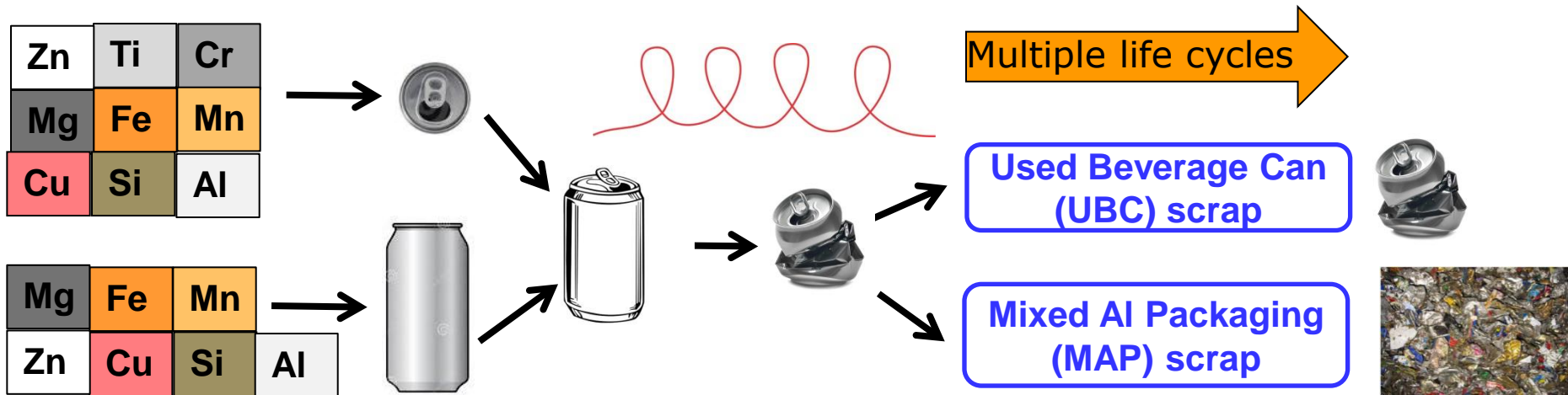
→ “*Circular economy-inspired FU*”: **containment** of 1 hl of beer
and supply of resources after its use stage for **30 loops**
1 recycling loop = 60 days (*EAA, 2015*)

Implications for LCI modelling

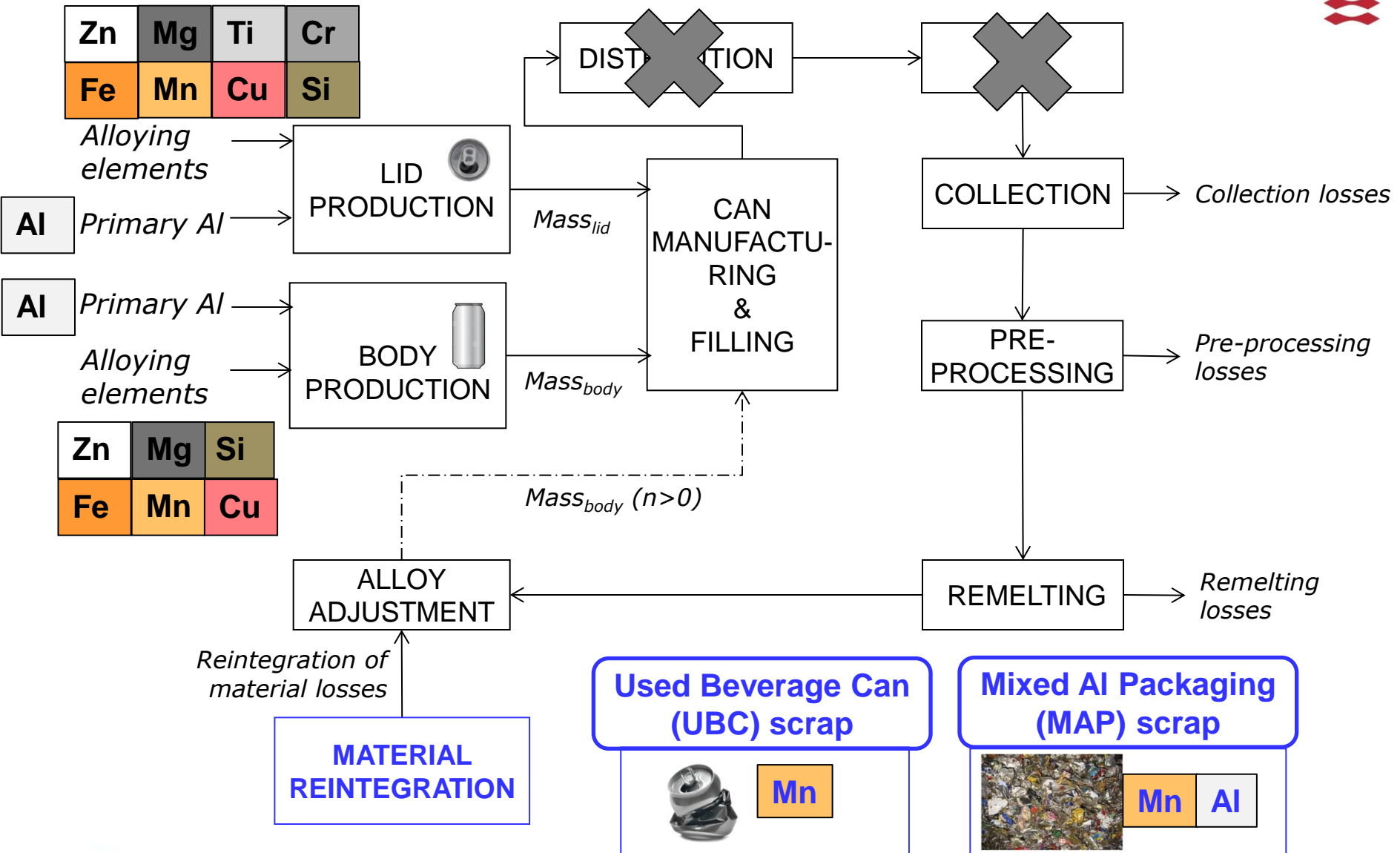
- Conventional LCA studies of aluminium products → based on a pure Al flow (*EAA, 2013*) **neglecting the presence of alloying elements**



- The **actual material composition** needs to be taken into account while addressing the use of aluminum in continuous loops

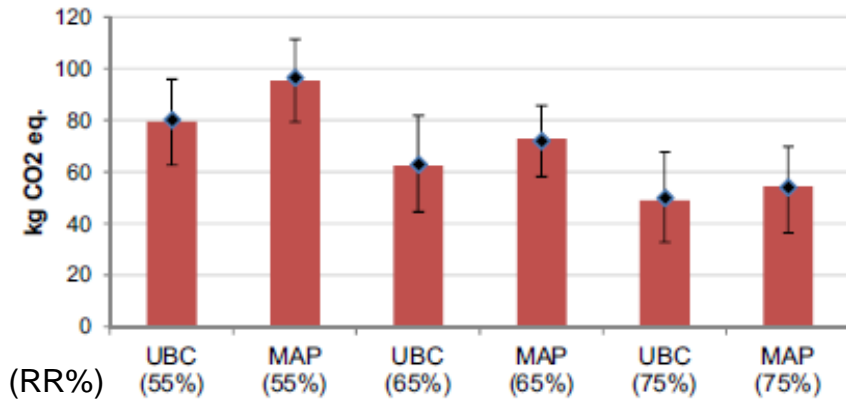


Mass Balance of alloying elements



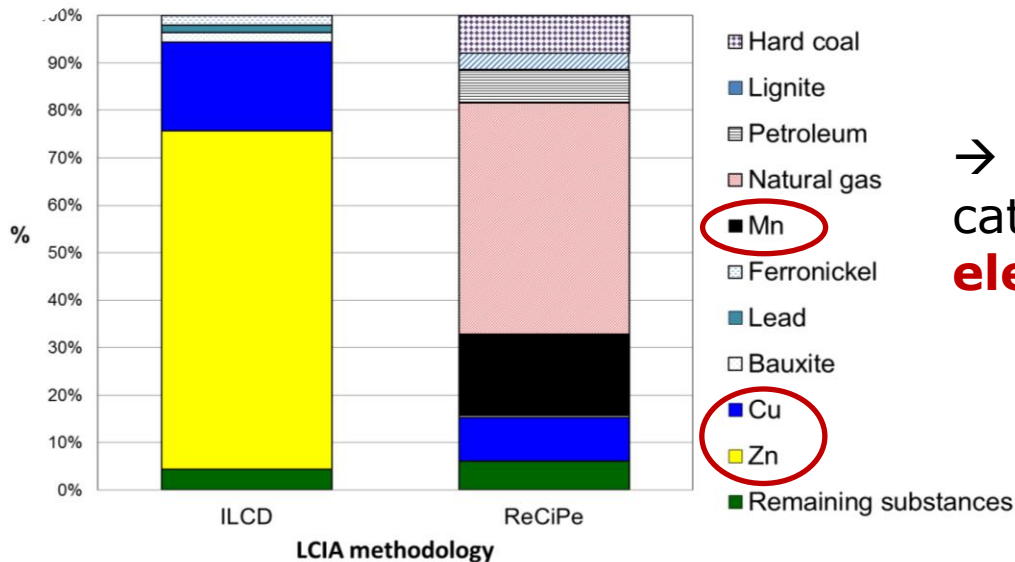
Results: LCA of multiple life cycles

Climate change



→ Closed product loop option (i.e. UBC scrap) has **lowest impacts** on climate change

UBC scrap – Recycling Rate (RR) = 65%



→ For resource depletion impact category contribution from **alloying elements** is relevant

Conclusions

→ **Answer to the Hamlet dilemma of AI can is TO BE in a closed product loop**

- How to implement a **cost-effective** can-to-can recycling system?
- Which are the effects of a closed product-loop strategy on aluminum scrap **market**?
-



→ **Multiple product loops can be modelled by LCA**

- Functional unit definition: include both **primary** (containment) and **secondary (supply of resource for next loop)** functions
- Life Cycle Inventory modelling based on the **actual alloy composition**

Zn	Fe
Mg	Mn
Si	Cu
Al	

How can LCA support the CE?



Research activities at DTU Management Engineering, Quantitative Sustainability Assessment (QSA) Division:

- ✓ **Decision support framework** for implementing circular economy strategies at product, organization, and supply chain levels

Example: **C**losed **L**oop **A**luminium **P**ackaging
(Climate KIC pathfinder project):



- Objective #1: **Combine** state-of-the-art insights from the knowledge pools “Technology”, “Business models”, and “Sustainability assessment”
- Objective #2: **Determine potential “paths”** towards a **closed-loop system** for **Al cans** with focus on CO₂ abatement potential and techno-economic feasibility

- ✓ **Risk and sustainability integrated assessment frameworks** for optimal use of chemicals and materials in a circular economy

Example: Coupling product use exposure with life cycle impacts:

- Objective #1: Identify **hot spots for CE** to focus risk minimization in multi-loop systems and to ensure both **safe and sustainable** CE development
- Objective #2: Consistently combine risk and sustainability indicators to **avoid burden shifting** in CE material cycles

Do you want to know the details?

- Niero M, Olsen SI (2016) ***Circular economy: to be or not to be in a closed product loop? A Life Cycle Assessment of aluminium cans with inclusion of alloying elements.*** Resources Conservation & Recycling 114: 18-31
- Niero M (2016) ***How to bridge the gap between the packaging sector and circular economy.*** http://www.carlsbergfondet.dk/en/Research-Activities/Research-Projects/Postdoctoral-Fellowships/Monia-Niero_How-to-Bridge-the-Gap-Between-the-Packaging-Sector-and-Circular-Economy
- Niero M, Negrelli AJ, Hoffmeyer SB, Olsen SI, Birkved M (2016) ***Closing the loop for aluminum cans: Life Cycle Assessment of progression in Cradle-to-Cradle certification levels.*** Journal of Cleaner Production 126, 352-362.
- Niero M, Hauschild MZ, Hoffmeyer SB, Olsen SI ***Combining eco-efficiency and eco-effectiveness for continuous loop beverage packaging systems: learnings from the Carlsberg Circular Community.*** Accepted for publication in Journal of Industrial Ecology – Nov 2016
- Niero M, Olsen SI, Laurent A. ***Renewable Energy and Carbon Management in the Cradle-to-Cradle certification: Limitations and opportunities*** - Under revision in Journal of Industrial Ecology

Acknowledgements

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Thank you for your attention!

Monia Niero, PhD
monni@dtu.dk

Division for Quantitative Sustainability
Assessment (QSA)
Department of Management Engineering
Technical University of Denmark
Bygningstorvet Building 115, room 014
2800 Kgs. Lyngby (Denmark)

