

Emissions in Technology Planning

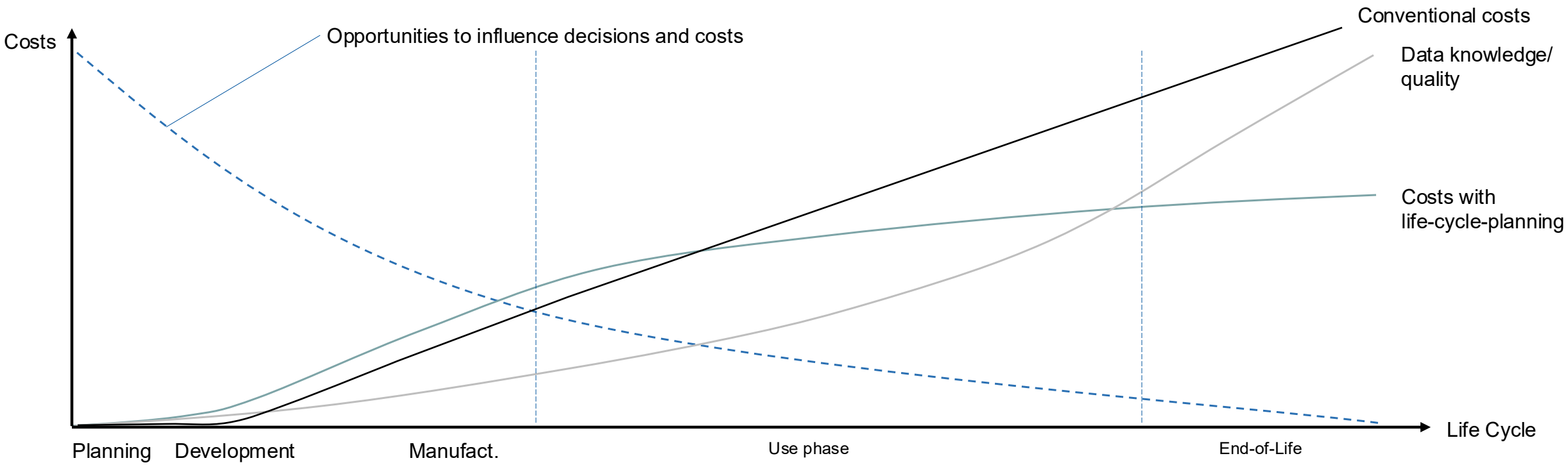
The relevance of a standardized sustainability assessment

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PEM | SAF | RWTH AACHEN UNIVERSITY

Product Life Cycle

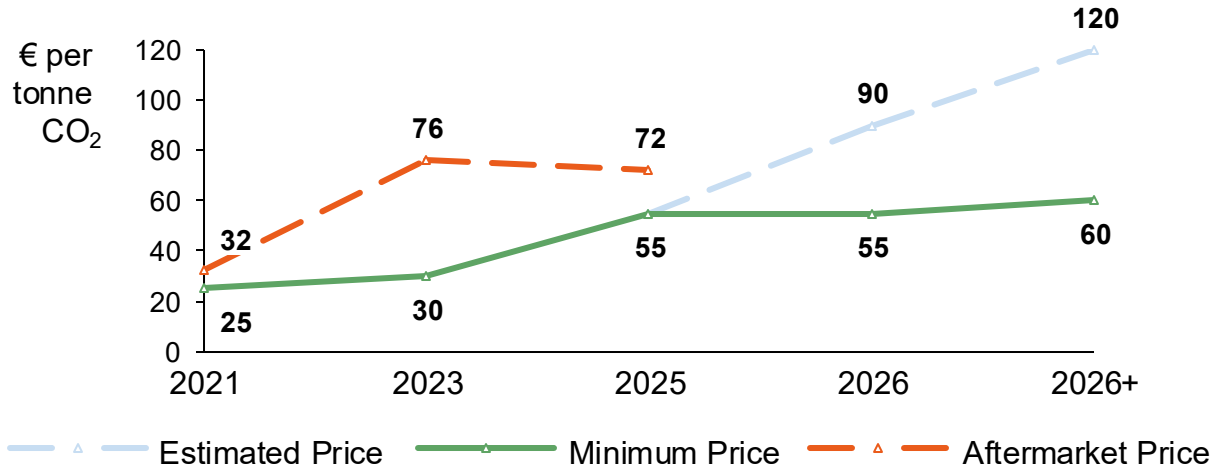
Sustainability assessment includes environmental, economic and social aspects.



Regulations and Emission-Cost Calculation

EU-ETS(2) & CBAM

- **Objective:**
  - EU-ETS: Reduction of greenhouse gas emissions through tradable emission certificates
  - CBAM: Ensuring fair competitive conditions for EU manufacturers by avoiding carbon leakage in non-european states
- **Sectors involved:** Energy-intensive industries (iron and steel, cement, aluminum, electricity, hydrogen)
- **Functionality:** Purchase of emission certificates corresponding to the emissions of energy-intensive imported or produced products
- **Full pricing** of emissions from **2034**, no more free certificates



Source: Study by berylls by AlixPartners; European Parliament; PEM RWTH study

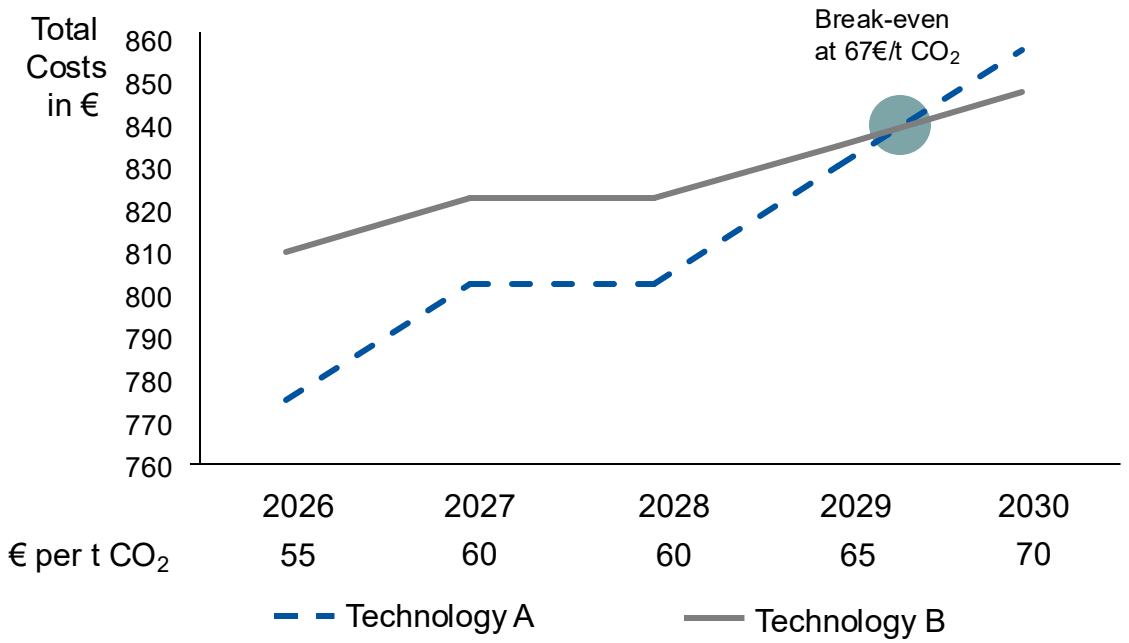
Take away

- Costs often not directly visible but factored along the value chain.
- EU-ETS costs as a relevant cost factor for components in the future.

Example: Regulations and Emission-Cost Calculation

Assumptions

- **Base costs (excluding CO_2):**
  - Technology A: €473
  - Technology B: €673
- **Production emissions:**
  - A: 6.0 t CO_2
  - B: 4.0 t CO_2
- **End-of-life/recycling credit:**
  - A: −0.5 t CO_2
  - B: −1.5 t CO_2
- **Net emissions = production − EoL:**
  - A: 6.0 − 0.5 = 5.5 t CO_2
  - B: 4.0 − 1.5 = 2.5 t CO_2



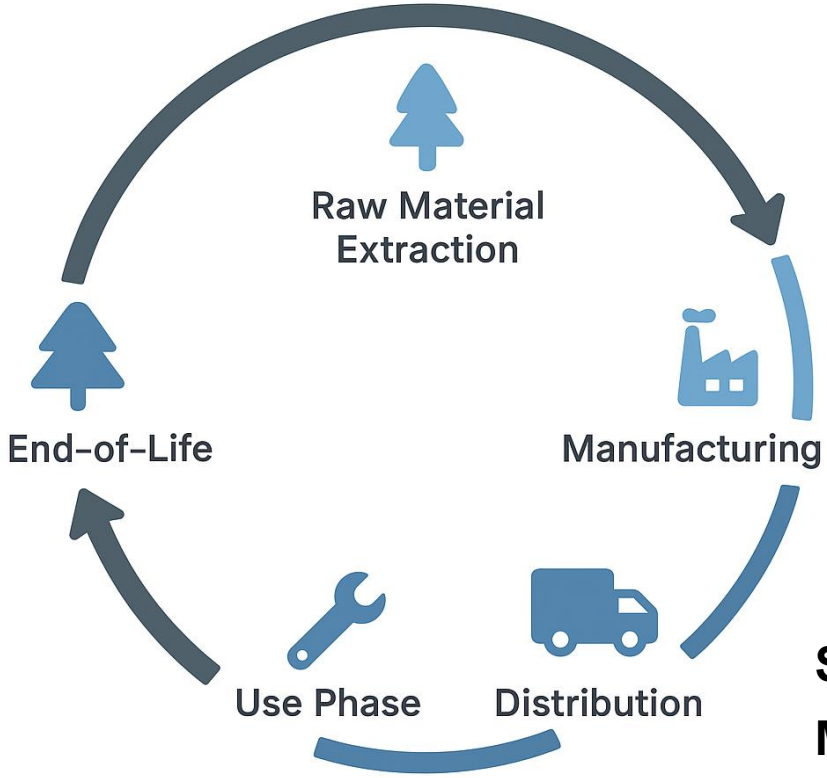
Take away

- Rising CO_2 prices reshape technology choices.
- Sustainability shifts from moral issue to economic factor.
- Accurate CO_2 balances become essential for planning.

Emissions in Technology Planning – Life Cycle Assessment

- Systematic method to evaluate the environmental impacts of a product, process, or service throughout its entire life cycle
- Best-known indicator (“KPI”): carbon footprint (CO_2e)
- Raw Material Extraction - End-of-Life

- Purpose:
  - Identify hotspots of environmental impact
  - Support sustainable design and decision-making
  - Compare alternative products or processes



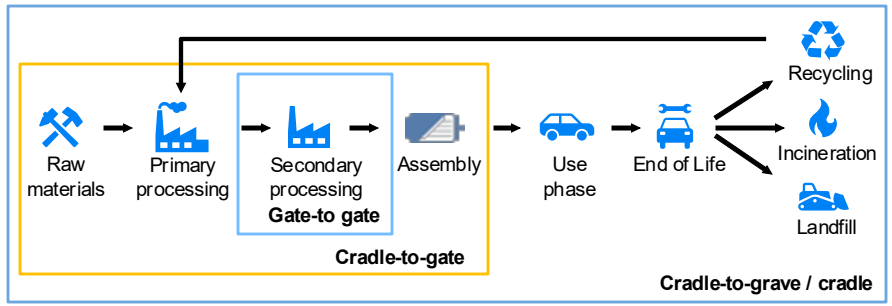
System boundaries & data

Modelling & Interpretation

Application

LCA of Electric Vehicle (cradle-to-gate) – Uncertainties: System boundaries & Data

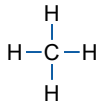
Necessary definition of frame of reference determines workload



Variation in calculation method may impact results

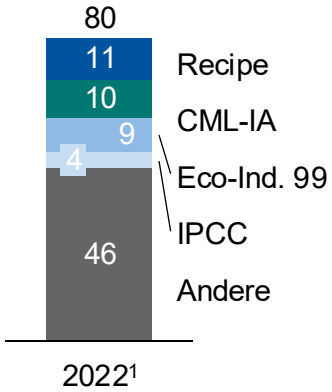
- GWP is the most used impact category
- Wide range of impact methods with varying conversion factors

CO_2 eq factor for Methane



ReCiPe (H): **36 kg CO_2e / kg CH_4**

CML-IA: **28 kg CO_2e / kg CH_4**



Data base selection & data collection determines quality of analysis

- Several databases available with varying values for common flows

CO_2 eq. for steel coil



Open access data: **1.98 kg CO_2e**

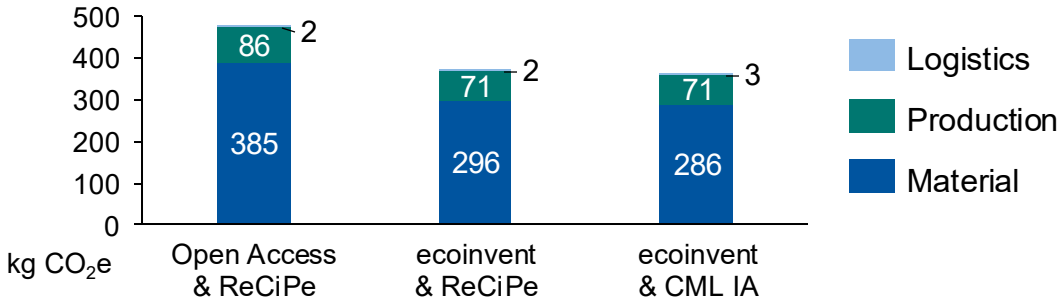
Ecoinvent v3.9: **1.69 kg CO_2e**

ecoinvent

exiobase

AIST IDEA Inventory Database for Environmental Analysis

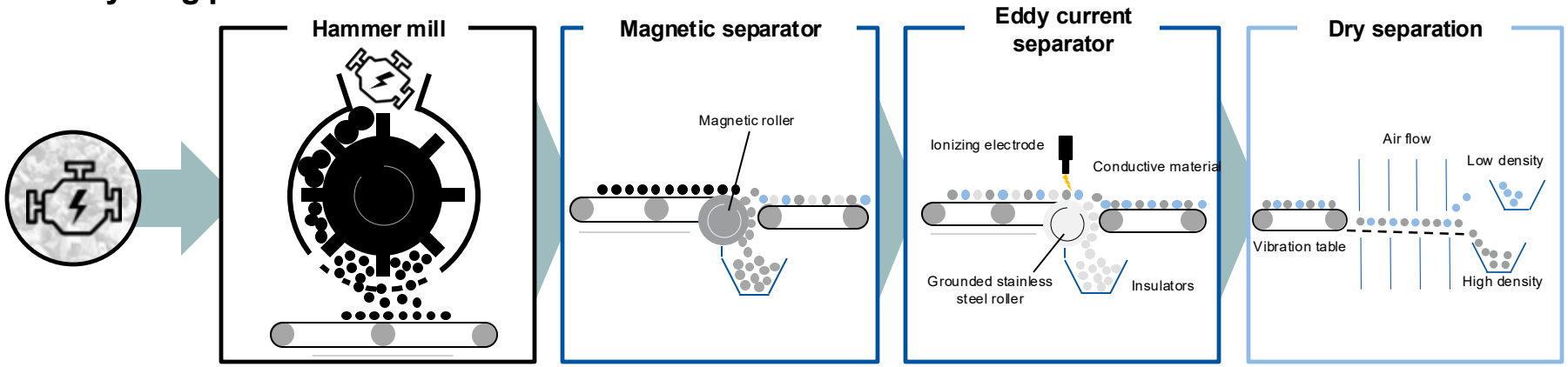
Depending on the data source & calculation method, the results change significantly[2] – even though identical BOM



1) Data from study of 80 LCAs in context of E-Mobility by Arshad et al. 2022
2) Result of cradle to gate PCF analysis by PEM of exemplary electric motor manufactured entirely in Germany

LCA – End-of-Life Challenges – Uncertainties: Modeling & Interpretation

State of the art recycling process:



Challenges:

Separation of materials
Materials cannot be cleanly separated by shredding due to adhesions and joints in the electric motor.

Production processes
Automated process technology for the high-volume dismantling of electric drives is not currently available.

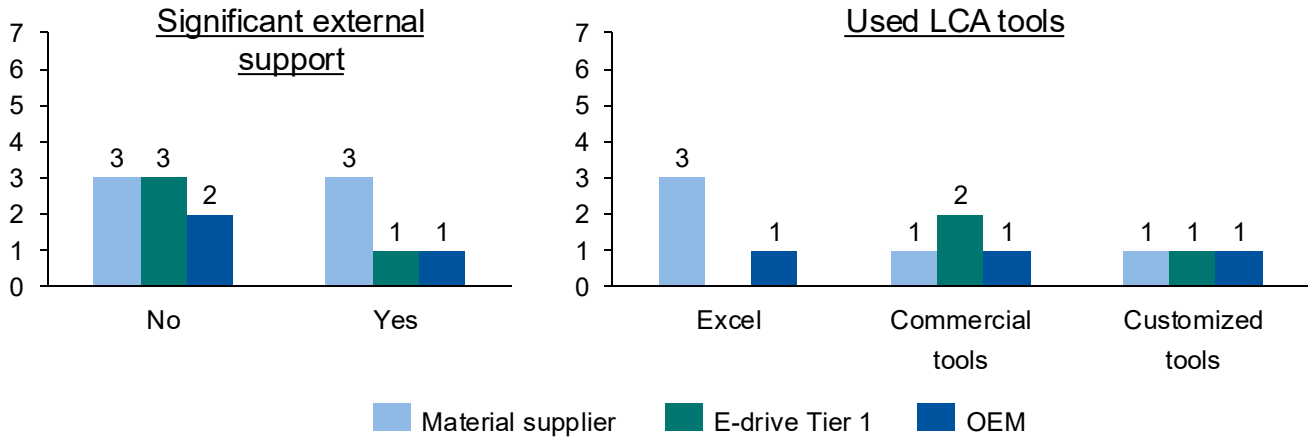
Product topology
Most of the current motor topologies are not designed for the disassembly and the reuse of individual components.

Information
The recycler does not have any product information, such as material compositions that are necessary for reuse or dismantling.

Assessment meth.
Diversity of assessment methodologies and indicators in LCA exists, no clear guidance which one to use – no comparability.

LCA – Uncertainties: Application

Placement of LCA within the company and allocated resources vary



Limited tracking through available resources

- While Excel may in some cases allow easy access to new users, data quality may suffer
- Dedicated tools provide transparent results with limited accessibility for new users
- An ERP-connected calculation tool could support consistent results with high initial cost

Access & user acceptance ⟷ Precision & transparency

Key findings

- Analyses are progressing from excel based calculations.
- Use of specialized tools may limit user acceptance due to new user interfaces & processes.
- More transparency necessitates company specific tools & databases closely linked to existing ERP-systems.

Summary

Data collection & assessment

Complexity

- Respondents highlight accurate tracking of product & process flows as a challenge while existing data sets help reduce complexity but do not accurately reflect the actual status quo

Comparability

- Use of varying datasets & calculation methods have major impact on results along the entire value chain, so that comparability of results limited

Verifiability

- According to responses, complete monitoring of emissions not feasible for all materials throughout the value chain

Accessibility & Interpretation

- Respondents state that information is fragmented and difficult to compile for the purposes of the analysis

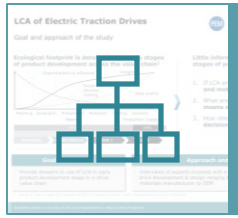
User experience & know-how

- Those tasked with development of the next generation of products still have **mostly limited exposure** to details of LCA method including a widespread lack of experience **around LCA that go beyond carbon footprint analyses**
- The **lack of** transparent **methods for dealing with** the high levels of **uncertainty** across the future product systems as well as the analysis itself limits the impact of LCA results on product design choices

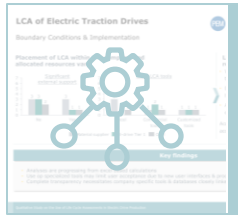
Standardization as solution – Future Outlook

Conclusion

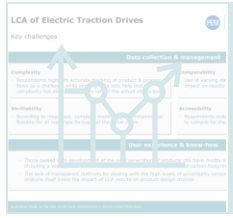
Key take-aways



Significant increase of sustainability assessments is to be expected, corresponding with increasing emission prices



Current environmental impact assessment comes with **methodological and assessment uncertainties**, with data gathering & quality as a key challenge



“Easy to use”/accessible (open access) systems are **necessity for establishment** of environmental assessments, both immediate as well as long term

Current LCA topics at SAF-PEM, RWTH Aachen

1. STANDARDIZATION OF LCA:

+ Definition of uniform modeling, no variables
+ Transparent consideration of uncertainty in the relevant aspects of life cycle assessment

2. CONSIDERATION OF COST AND SOCIAL EFFECTS:

+ Consideration of cost and social effects in early stages for integrated assessment of environmental, social and economical impacts of technology decisions

3. EASE OF USE VIA AI AND ML:

+ Implementation/development of open access tool connected with established ERP-systems do improve usability and assessment quality



Thank you for your attention.

Munich, 05th of November

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