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Hemp's Sustainable Futu

Insights on LCA Data Management

IHBA
2023

Life Cycle Assessment (LCA)

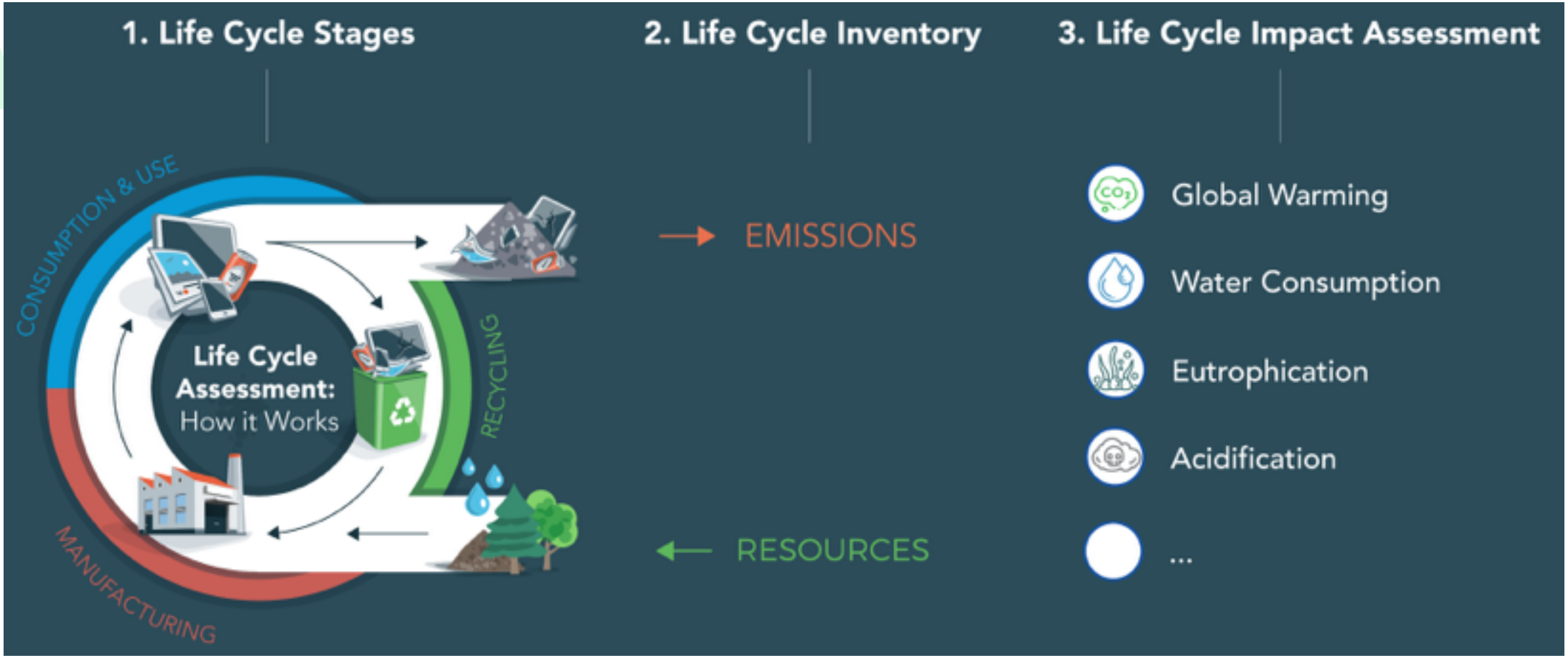


Fig.1 Infographic LCA (Sphera 2020)

LCA

Standardization

Embodied Carbon

Operational Carbon

EN 15804 / EN 15978

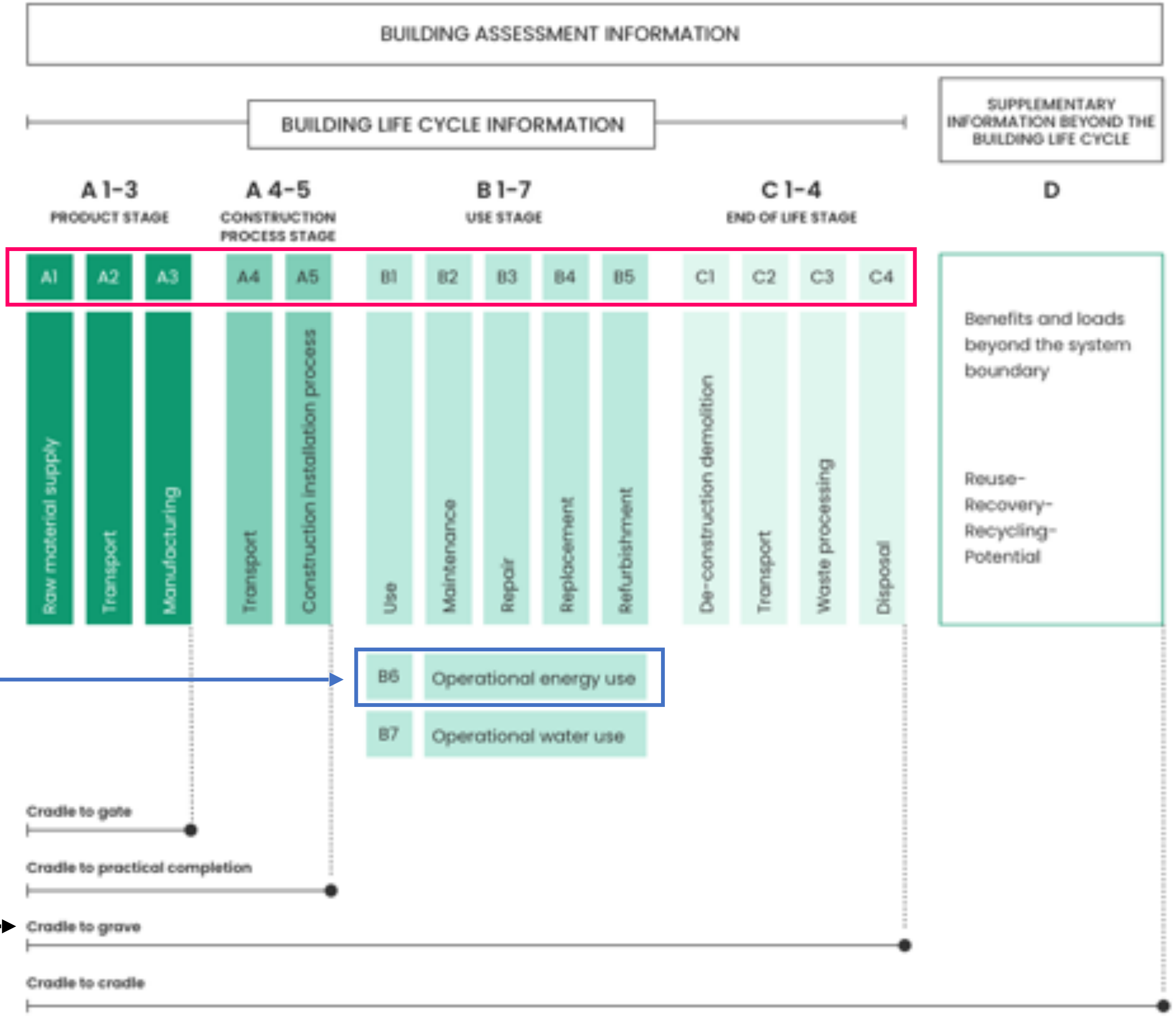
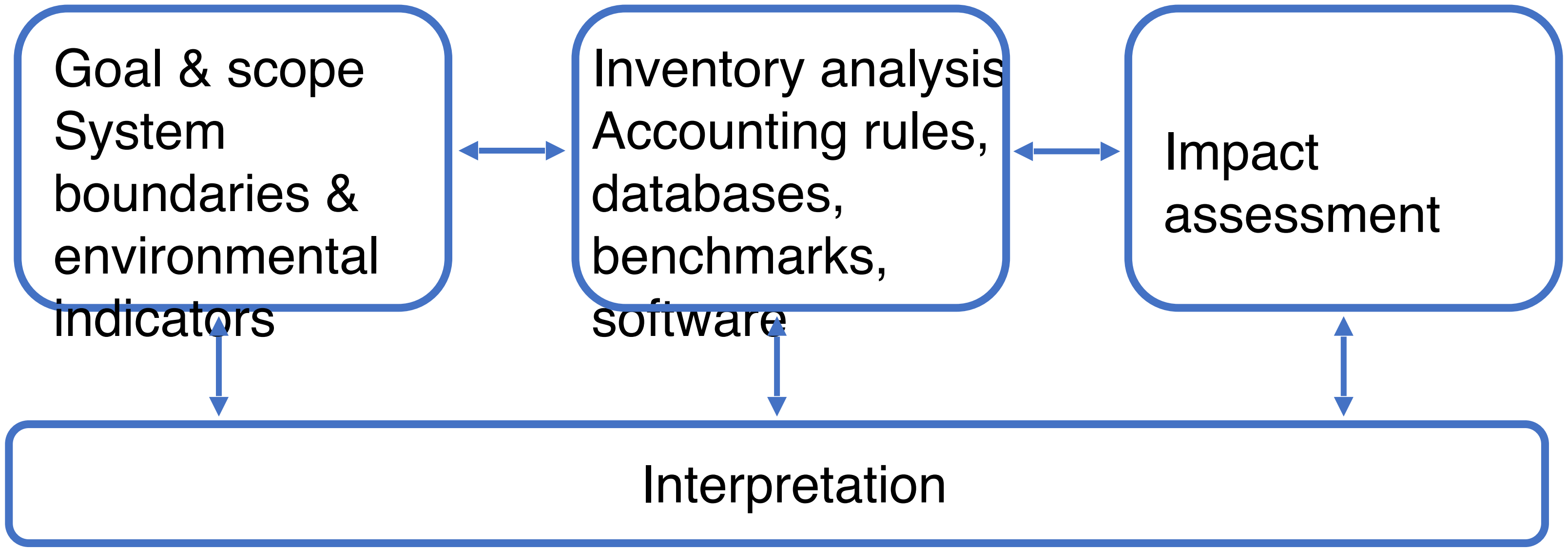


Fig. 2 Life Cycle Stages according to EN standards (OneClick LCA 2023)

Standardization

- **ISO 14040**: Environmental management – Life cycle assessment – Principles and framework & **ISO 14044**: Requirements and guidelines
- **Phases of an LCA** (ISO 14040:2006):

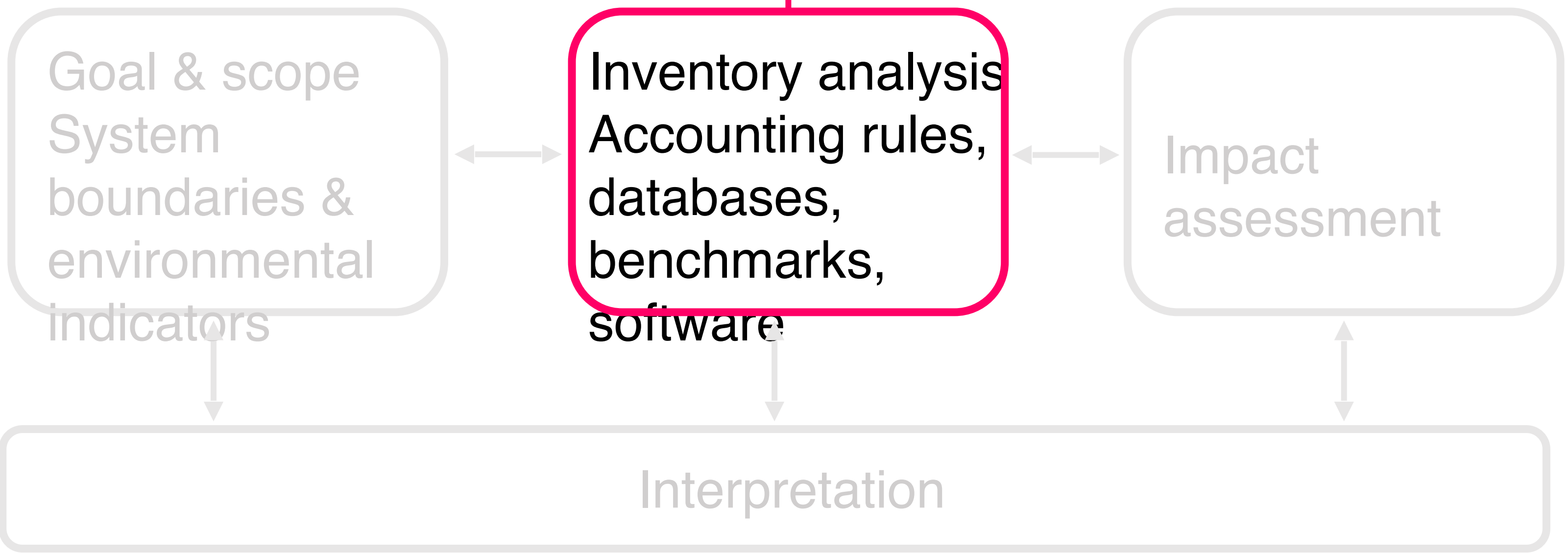


LCA Applications:

- Quantify environmental impacts
- Compliance with funding program & legal requirements
- Comparison of options

Standardization

Quality (integrity and transparency) of software & data influences the reability of the LCA results, as well as user competence!



LCA

Standardization

Research Excursus

- Building products:
  - **EN 15804:2022** → EPDs– core rules & methodical requirements
  - **EN 15942:2022** → EPDs- communication format business-to-business
- Buildings:
  - **EN 15643:2021** → Framework for assessment
  - **EN 15978-1:2021** → Methology for the assessment of environmental performance
- Quality assurance for data and assessment results:
  - **EN 15941:2022** → Data quality for environmental assessment (selection & use)

Certification systems

Fig. 3 Certification systems worldwide (nbau 2023)

Databases

- **National databases, e.g.:**

ÖKOBAUDAT Nationale Milieu DATABASE AusLCI EPD ITALY epddanmark KBOB GBCe

- **International softwares and databases, e.g.:**

sphera coinvent database & GaBi database) Ecochain ;)

SimaPro openLCA

- **Environmental product declaration (EPD):**

41.000 EPDs in Europa, but different system boundaries!

→ **LCAs difficult to compare because of different databases and system boundaries!**

(Ecochain 2023)

LCA

Comparability

- Schlegl et al. (2019): Only 22 out of 838 building LCAs (3%) comparable because of:
  - Different guidelines/software/data/building types, incomplete data & user inaccuracy

→ **Propose for (legally binding) full life cycle-related benchmarks to establish budget-based targets to decarbonize the construction sector!**

- Harmonisation in Europe through:
  - European database: **Product Environmental Footprint (PEF)** by end of 2024
  - European software: **Ecochain** (PEF included)
  - **IEA EBC Annex 72**

(Schlegl et al. 2019; Weidner et al. 2021; Braune et al. 2021; Le Den X et al. 2022; Frischknecht et al. 2019)

(IEA EBC 2023)

LCA

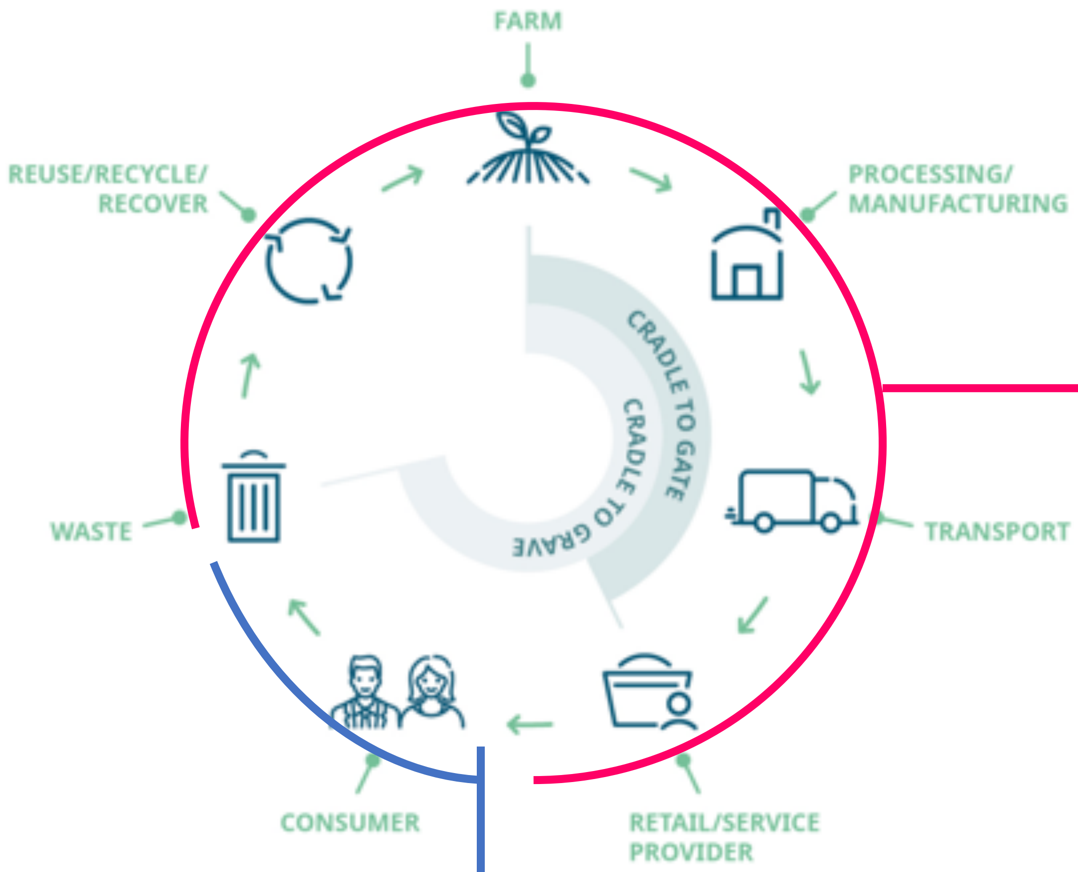
Comparability

Research Excursus

- **Current state of research:**
  - Finland (whole life cycle A-C, 50 years)
  - → Target 2025: 10-14 kg CO_2e/m^2a
  - Denmark (whole life cycle A-C, 50 years): 2023: 12 kg CO_2e/m^2
  - → Target 2029: 7,5 kg CO_2e/m^2a
  - France (whole life cycle A-C, 50 years): 2022: 12,8-14,8 kg CO_2e/m^2a
  - → Target 2031: 9,8 kg CO_2e/m^2a
  - UK (whole embodied carbon, 60 years)
  - → Target 2025: < 10,8 kg CO_2e/m^2a

What has the biggest impact on the environmental effects in the building LCA?

Biggest impacts



EMBODIED CARBON
10% OF GLOBAL GHG

= GHG emissions associated with materials and construction processes throughout the whole life cycle of a building.

OPERATIONAL CARBON
28% OF GLOBAL GHG

Fig. 5 Life cycle stages of a product, reffered to here to building industry (Kerry Health and Nutrition Institute 2022)

LCA

Biggest impacts

- High-Rise Residential Building, India:

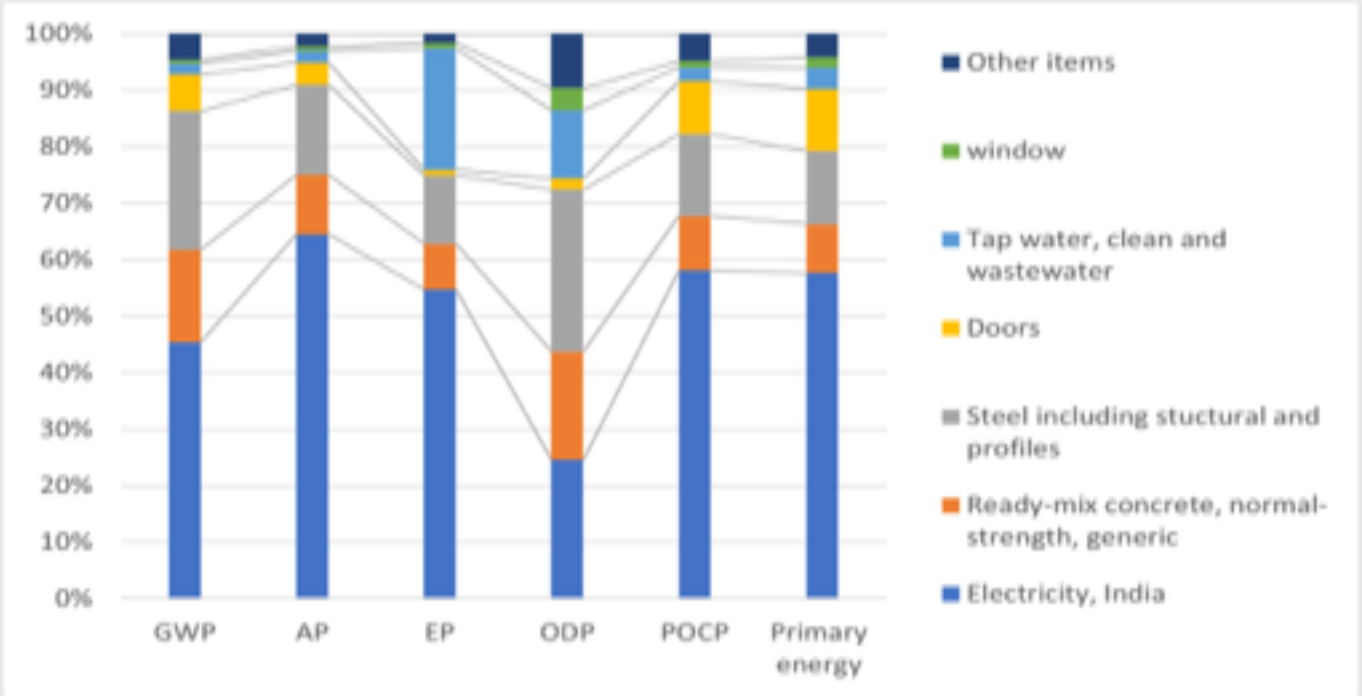


Fig. 6 Life cycle impact by materials (Alotaibi et al. 2022)

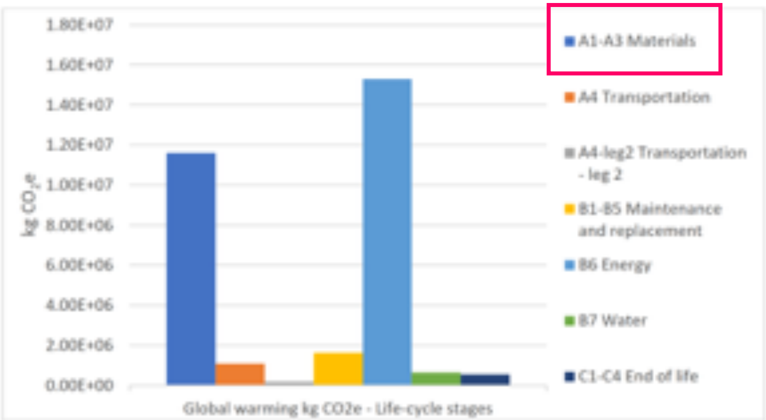


Fig. 7 Embodied carbon based on life cycle stages (Alotaibi et al. 20

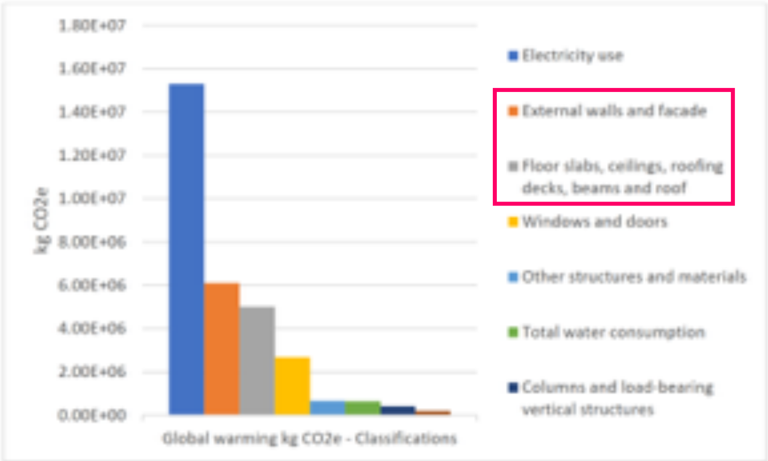


Fig. 8 Embodied carbon on element classification (Alotaibi et al. 202

- Operational Carbon 49.4%
- Embodied Carbon 37.5%

→ **After electricity, bearing structure has the biggest impact!**

LCA

Biggest impacts

- Schlegl et al. (2019) Results:

→ GWP: 70% operational carbon, 30% embodied carbon (80% A1-A3)

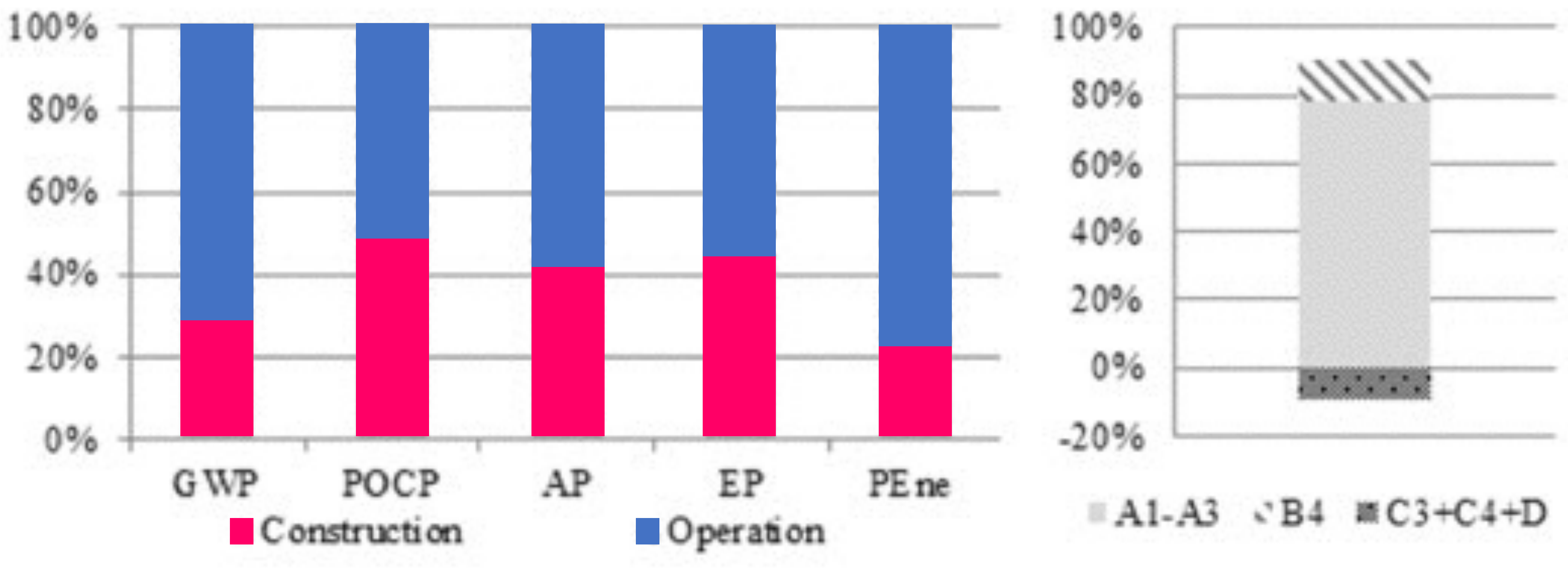


Fig. 9 Average distribution of the construction and operation of different impact indicators, GWP of construction in detail on the right side (Schleglet al. 2019)

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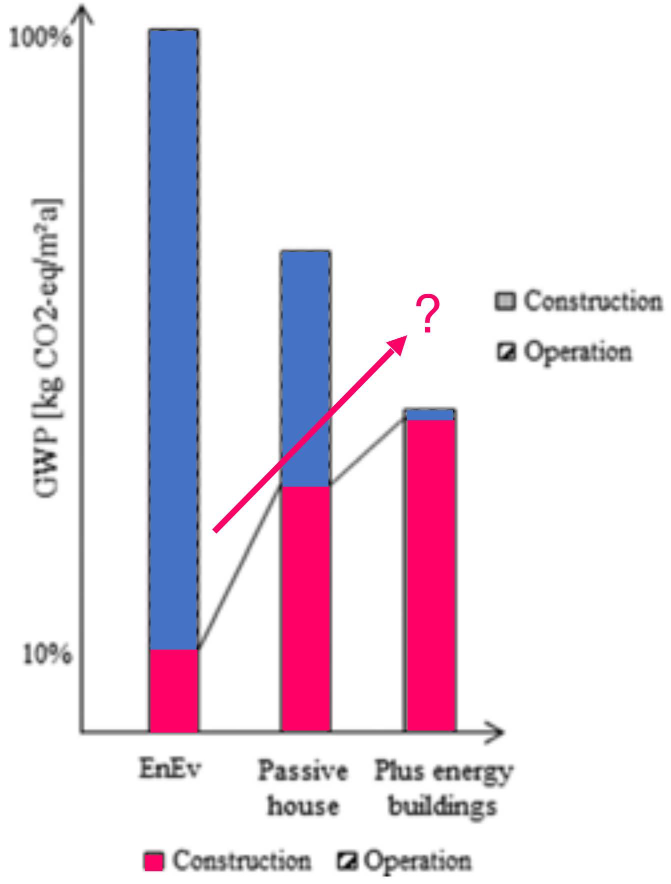
Biggest impacts

- **Past/Current focus:** Increasing energy efficiency in building operation.
- **New focus:** Increasing importance of embodied carbon related to construction **material production, processing and recycling**.

→ **From climate-neutral operation to climate-neutral building!**



(Weidner et al. 2021)

Fig. 10 Qualitative development of GWP's share for construction and operation (Schlegl et al. 2019)

Hempcrete data

Development of data on CO2 emissions for hempcrete products (according to manufacturer information)		A		B		C		
		Hemp lime stone		Hemp lime stone		Hemp lime stone	Bulk material	Spraying method
		2017		2018	2021	2022		
[kg CO_2/m^3]	GWP $_{ges.}$	106,92	189,69	-75,33	102,48	-44,21	-105,09	-104,17

Life Cycle Phases:

A = A1-A3, C2-C4, D

B = A1-A5, B1-B5, C1-C4 (2018)

A1-A5, B1-B5, C1-C4, D (2021)

C = A1-A5, B1, C1-C4, D

What can be deduced from this?

- Results vary depending on system boundaries, databases, etc.
- Phase D - how to deal with it? (Generally: also an issue with wood)
- When is carbon sequestration considered?
- CO2 negativity? → Has Cradle to Cradle been adhered to?
- External communication

Conclusion

- LCA ≠ LCA! Different results due to different data/method/time horizon etc. At state, numbers hardly comparable!

  → Be aware and consider/compare underlying parameters of inventory analysis for profound judgement!

- Need for international harmonisation of data and methods (benchmarking)
- Upcoming Focus on embodied carbon = Potential for hemp building and other natural materials
- Careful: Numbers will never get the whole picture! Quality ≠ Quantity

LCA

Potentials/ improvements of hemp materials

1. **Carbon-negativity in Cultivation/ Production (Phase A1-A3)**
   →Carbon sinks in biomass and soil, enhanced biodiversity (insects, bacteria etc.) minimal use of pesticides/fungicides

2. **Carbon-negativity in Reuse-Recovery-Recycling (Phase D)**
   →Hemplime remains in high quality technical cycles due to its largely monolithic structure, easy recovery, and recyclability

3. **Regional Aspects of Hemp Materials Production (Phase A1-A3)**
   →Structural transformation, job creation, regional supply chains, low-tech, low carbon production

4. **Simplification of Conventional Building Process (Phase B1-B5)**
   →Hemplime combines insulation, thermal mass, healthy housing, ease of construction and more

Potentials/ improvements of hemp materials

5.Water Efficiency in Cultivation (Phase A1-A3)
→ Relatively little water consumption, enhanced soil quality leading to better water retention

6. Durability & Longevity (Phase B2-B5)
→Hemplime's easy of repair and longlivity can expand life span of building

7. Biodegradable End of Life Process (Phase C1-C4)
→Hemp structures are decomposable by natural processes

8. Recycling and Reusability (Phase D)
→Easy recyclable, minimal waste and promotes reuse or organic end-of-life processes

9. Economic Boost in Rural Areas (Phase A1-A3)
→Hemp offers new employment and income avenues, especially in rural regions (SLCA – Social Life Cycle Assessment)

LCA

Further questions for discussion

- How much CO_2 is stored in hemp and in the soil during cultivation?
- How does hempcrete behave during composting/thermal processing?
- How can we establish supply chains that ensure a meaningful technical cycle for hemp building materials? Should manufacturers have a responsibility for the recycling of hempcrete waste?
- What standards are needed for hempcrete “waste” to be used in situ or within the region…
  - as dry fill, for composting (returning to the biological cycle), for thermal processing
  - Can hempcrete ash serve as binder with pozzolan for new hempcrete
- What are your arguments when dealing with customers and partners about LCA of hemp building materials?
- Can CO_2 pricing models simplify LCA?

Call to action

Discussion:
Where should we start to improve the LCA of hemp building materials?

…Let‘s get ready for cradle to cradle!

LCA

Cited Literature

- https://sphera.com/glossar-de/was-ist-lebenszyklus-beurteilung-lca/?lang=de (last downloaded 05.10.2023)
- https://oneclicklca.zendesk.com/hc/en-us/articles/360015064999-Life-Cycle-Stages (last downloaded 05.10.2023)
- Le Den X, Steinmann J, Röck M, Birgisdottir H, Horup L H, Tozan B, Sørensen A. Towards EU embodied carbon benchmarks for buildings - Summary report, 2022.
- Essig, N. (2022): Qualitätssiegel Nachhaltiges Gebäude (QNG) - Warum erst jetzt? Hrsg.: nbau. Nachhaltig Bauen. Berlin https://www.nbau.org/2022/06/23/qualitaetssiegel-nachhaltiges-gebaeude-qng-warum-erst-jetzt/ (last downloaded 05.10.2023)
- https://ecochain.com/blog/lci-databases-in-lca/ (last downloaded 05.10.2023)
- F. Schlegl, J. Gantner and R. Traunspurger et al. (2019): LCA of buildings in Germany: Proposal for a future benchmark based on existing databases. Published: Energy & Buildings 194. S. 342–350.
- Weidner, S.; Mrzigod, A; Bechmann, R.; Sobek, W. (2021): Graue Energie im Bauwesen - Bestandsaufnahme und Optimierungsstrategien. Published: Beton- und Stahlbetonbau116, H. 12, S. 969-977.
- Braune, A.; Ekhvaia, L.; Quante, K. (2021): Benchmarks für die Treibhausgasemissionen der Gebäudekonstruktion. Published: DGND e.V. Stuttgart
- Le Den X, Steinmann J, Röck M, Birgisdottir H, Horup L H, Tozan B, Sørensen A: Towards EU embodied carbon benchmarks for buildings - Summary report, 2022. Published in Ramboll. Brussels
- Frischknecht, R.; Balouktsi, M.; Lützendorf, T. et al. (2019): Environmental benchmarks for buildings: needs, challenges and solutions - 71st LCA forum, Swiss Federal Institute of Technology, Zürich, 18 June 2019. Published: The International Journal of Life Cycle Assessment
- Energy in Buildings and Communities Programme (2023): IEA EBC Annex 72: A programme of the International Energy Agency (IEA) https://annex72.iea-ebc.org/about (last downloaded 05.10.2023)
- Alotaibi, B.S.; Khan, S.A.; Abuhussain, M.A.; Al-Tamimi, N.; Elnaklah, R.; Kamal, M.A. (2022): Life Cycle Assessment of Embodied Carbon and Strategies for Decarbonization of a High-Rise Residential Building. Published: Buildings 2022, 12, 1203.
- United Nations Environment Programme UNEP (2020): Executive summary of the 2020 global status report for buildings and construction.
- One Click LCA (2021): Embodied Carbon Benchmarks for European Buildings https://www.oneclicklca.com/wp-content/uploads/2021/06/Embodied-Carbon-Benchmarks-for-European-Buildings-10-June-2021-FINAL.pdf?vgo_ee=DefiqFUhQkNXl3l1CQLFjI7KpEho6LWkZA9N%2FxgSkzATQH6fg%2FA%3D%3Au6jk9qe7676VsWLOAGYI3m2WZXlEPyfS (last downloaded 05.10.2023)
- The Danish Housing and Planning Authority (2021): The National Strategy for Sustainable Construction. Published: Ministry of the Interior and Housing. Copenhagen.
- Dr. Werner F.; Umwelt & Entwicklung [Zürich]; „Arbeitsbericht für doe unabhängige Prüfung der Berechnung der Indikatorwerte von Hanf-Kalk-Ziegel aus Hanf und Kalk des Schönthaler Betonsteinwerks für die KBOB-Liste bzw. als Projektbericht gemäß EN 15804“
- EPDItaly „Environmental Product Declaraction Hemo and Lime Biocomposite Building Products“; SEN-01_22; 29/09/2022
- IsoHemp „ Life cycle assessment IsoHemp hemp blocks” Liège Université
- Service public fédéral Santé publique, Sécurité de la Chaîne alimentaire et Environnement «ISOHEMP PAL36 – Bloc de béton chanvre - 1 m² de blocs de béton chanvre installés » 16.09.2021

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