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What CLCA is and isn't (and what's missing)

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Content

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- CLCA, how it's done, technically
- How it's done, practical questions
- Conclusions
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CLCA, definition & motivation

CLCA, definition and motivation

- CLCA means consequential LCA, which is the "counterpart" of attributional LCA.

Attributional approach*:* System modelling approach in which inputs and outputs are attributed to the functional unit of a product system by linking and/or partitioning the unit processes of the system according to a normative rule. [1]

→ A tiny share of the existing market represents the product that is meant to be modeled, it is "attributed" to your model.

German electricity market: 2019 in total: 612.4 billion kWh; product system: 1 kWh
-> average electricity production input and output flows *1/621.4 billion =
= input and output flows for the process in the product system.

[1] UNEP 2011, Shonan Guidance Principles, glossary

CLCA, definition and motivation

- CLCA means consequential LCA, which is the "counterpart" of attributional LCA.

  Consequential approach: System modelling approach in which activities in a product system are linked so that activities are included in the product system to the extent that they are expected to change as a consequence of a change in demand for the functional unit . [1]

  → Model the market as a consequence of producing the product amount as required by your study.

  As a consequence of the request for 1 additional kWh electricity in the German electricity grid, new Solar Cells are established, and their inputs and outputs are thus used, scaled to 1 kWh, for modeling the impact.

[1] UNEP 2011, Shonan Guidance Principles, glossary

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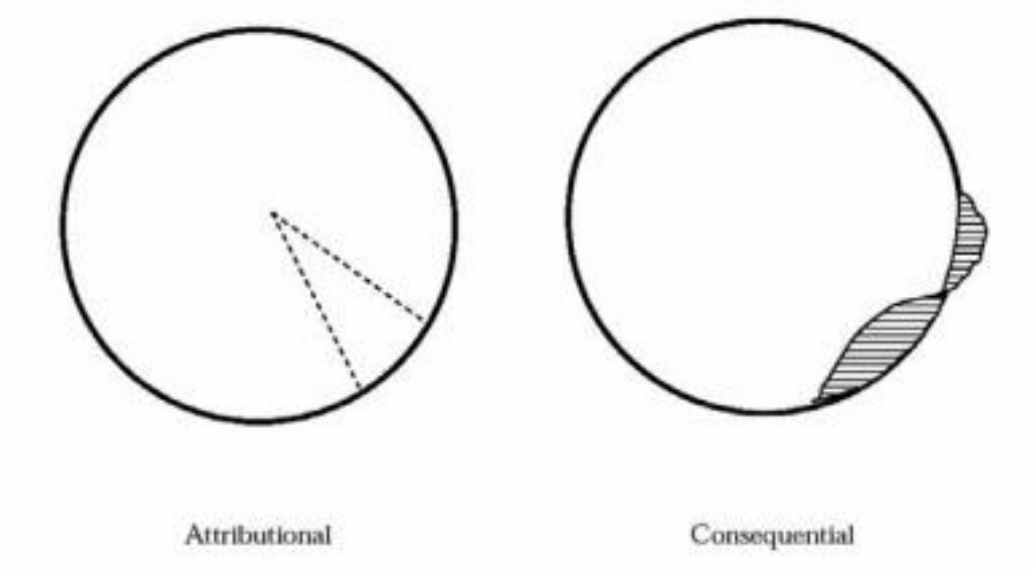


Weidema B et al. (2003) Procedural guideline for collection, treatment, and quality documentation of LCA data, CASCADE project report, version 5, January 22, 2003, p. 15

CLCA, definition and motivation

- LCA is about decision support; decisions are typically meant to change something.
- Assumption in attributional LCA:

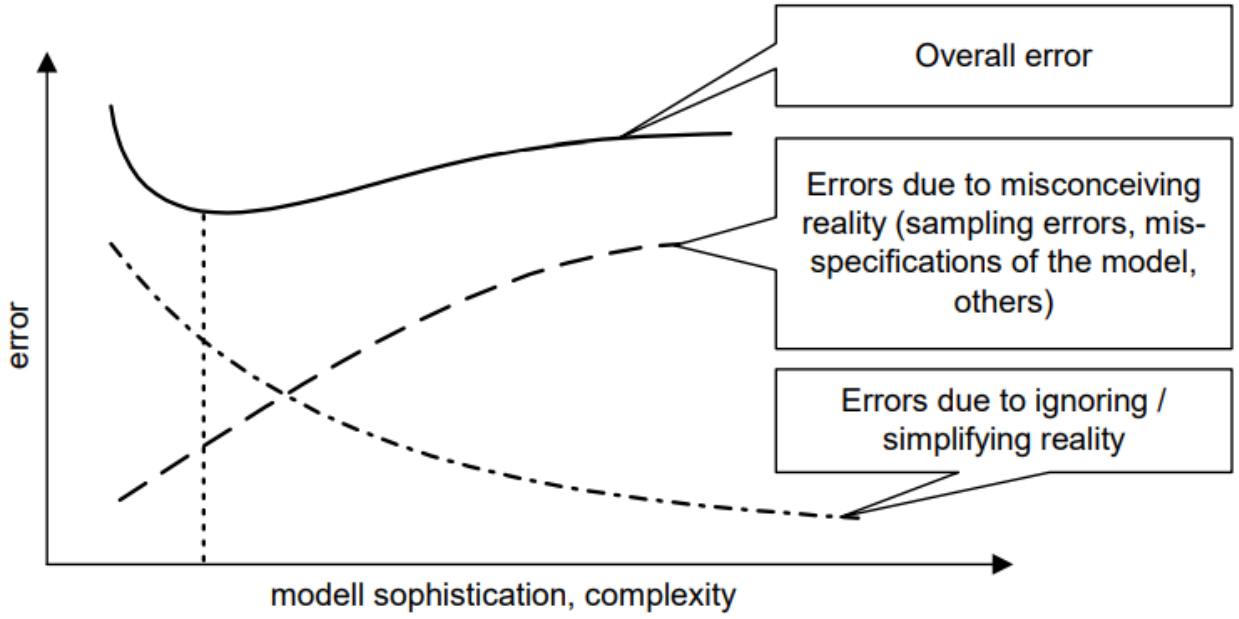
  "The choice of the functional unit of the product alternative investigated should not influence other activities on the planet" (Heijungs et al. 1992, p. 12;

  → Motivation for consequential LCA: model LCA in case ceteris paribus assumption is not met (simply speaking)

[1] Heijungs, R., J.B. Guinée, G. Huppes, R.M. Lankreijer, H.A. Udo de Haes, A. Wegener Sleeswijk, A.M.M. Ansems,P.G. Eggels, R. van Duin, H.P. de Goede (1992) Environmental Life Cycle Assessment of products. Guide and Backgrounds. NOH reports 9266 & 9267 Leiden

CLCA, definition and motivation

- Side consideration: Modeling the consequences of a decision is more difficult than attributing a share; it is a model sophistication



Ciroth, A.: Uncertainties in Life Cycle Assessments, Editorial, Int J LCA 9 (3) 141 – 142 (2004)

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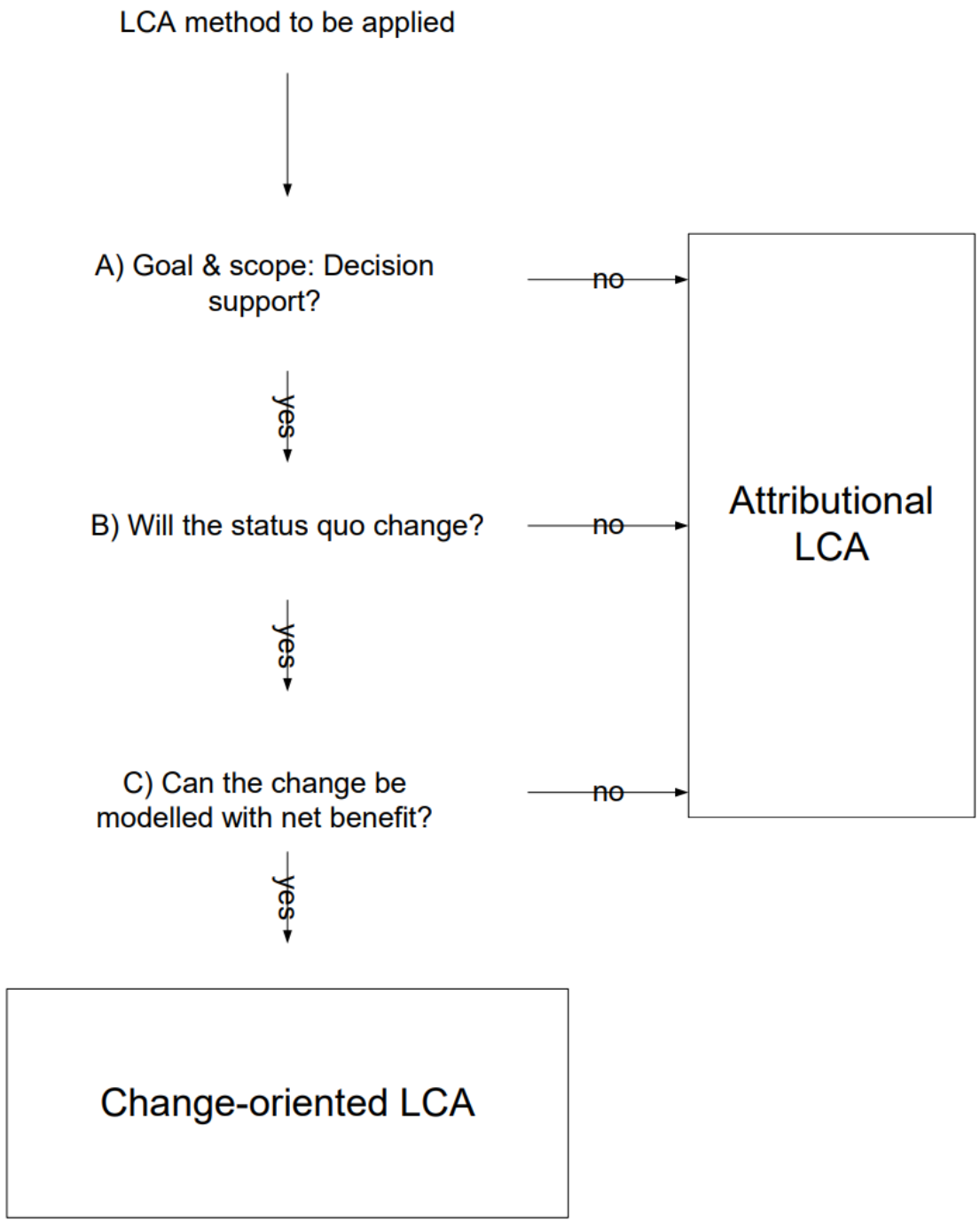
CLCA, when to use?



Ciroth, A., Lundie, S. Huppe, G.: Inventory methods in LCA: towards consistency and Improvement, Müller, 2007, p. 13

CLCA, how it’s done

CLCA, how it‘s done: e.g., ecoinvent

- Consequential, long term is one of the three system models of ecoinvent, meant for CLCA calculation
- Principle: constraint markets, new technologies instead of market supply, when constraints “kick in”
- Was introduced with ecoinvent 3.0 and is now a bit difficult to follow
- Evidently, consequential modeling is always challenging for a background database (meant to be used for any amount of functional unit)

CLCA, how it‘s done: e.g., CGE

- CGE = computational equilibrium models
- E.g. Yi, Heijungs 2018 [1]
- With various assumptions, including profit maximization of market actors, a linearity of production (“constant returns to scale”), a non-linear market equilibrium can be calculated, using established macro-economic models
- This market equilibrium then yields the production from different producers in the market

[1] Yang, Yi & Heijungs, Reinout. (2018). On the use of different models for consequential life cycle assessment. The International Journal of Life Cycle Assessment. 23. 751–758. 10.1007/s11367-017-1337-4.

CLCA, how it's done, practical

CLCA, practical

- Actually, in my perception, CLCA is not broadly applied yet, apart from some “convinced disciples”
- CLCA has been debated in LCA since > 20 years
- Practical questions:

  a) With which technology will the additional market demand be satisfied when there are market constraints

  b) How to model “market ripple effects” that happen when changing a market for one product that affects other markets

CLCA, practical

a) With which technology will the additional market demand be satisfied when there are market constraints

e.g., additional demand for person transport :

- Optimised diesel car, personal
- Hybrid car, personal
- Hydrogen fuelled car, personal
- E-car, personal
- Sharing concepts, with car technology x, y, z
- …

CLCA, practical

b) How to model “market ripple effects” that happen when changing a market for one product that affects other markets

e.g., Produce corn in Luxembourg for biodiesel, on what is now meadows with cows, due to incentives for farmers:

- What do dairies, beef producers do?
- What do soybean, feed producers do?
- What do existing corn producers do?
- How many farmers switch to corn, for how long?
- …

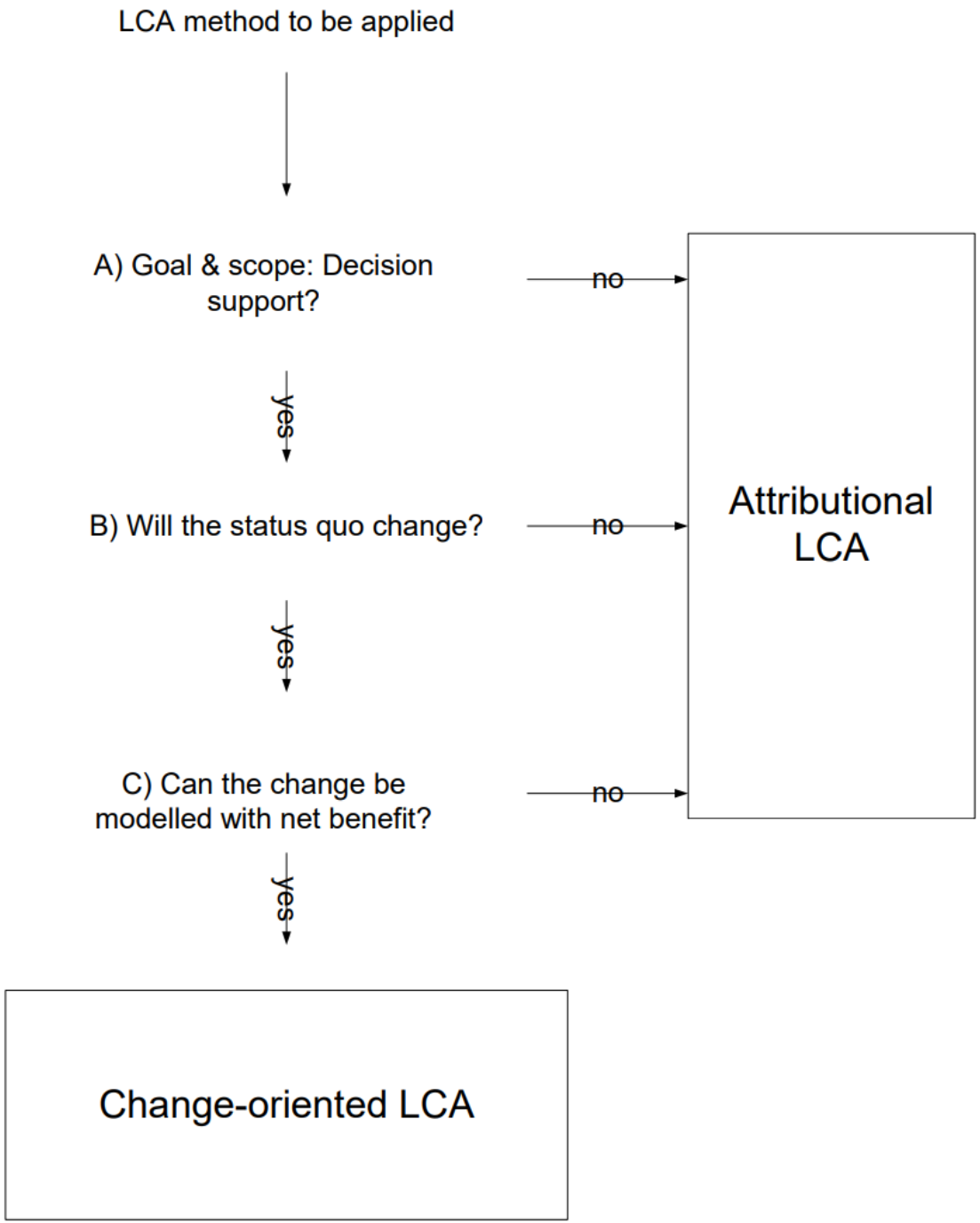
CLCA, conclusions

CLCA, conclusions

A) Probably 95% yes

B) Maybe 33% yes (including prospective LCAs)

C) Hard to say. Quite low probably. This needs more attention.



CLCA, conclusions

- CLCA shows that LCA is about modeling. Always.
- Attributional modeling is more reproducible and more stable and easier to do and to accept
- Always, however, you will want to validate your model
- I believe we as LCA community need to make progress in LCA model validation:
  - Be transparent about model assumptions
  - Try to test whether the model is correct (does what it is supposed to do)
- We have not developed these model validation capabilities a lot yet
- They are more important for more sophisticated models

A way forward

A way forward: (towards) LCA and especially CLCA model validation

„Try to test whether the model is correct / does what it is supposed to do“

– what does this mean?

A way forward: (towards) LCA and especially CLCA model validation

- Now: CLCA is model sophistication, the resulting LCA models are more complicated, not linear, potentially more realistic but also less stable systems

→ Using CLCA is more a matter of believe or of being a fan, even though models are used that are common in other domains

→ If we want understand whether CLCA can be modeled with „net benefit“, we need to understand the effort for creating the CLCA model, and how good it is able to model the changed market and life cycle

A way forward: (towards) LCA and especially CLCA model validation

how good it is able to model the changed market and life cycle

This refers to:

→ Processes in the life cycle (maybe happening in future)

→ Market changes, repercussions, i.e. supply chain linking and share in average products

→ When the model is initially created

→ When the model is used → monitoring.

CLCA model validation: what can be „inspected“

- For a process in the model:
  - Rules followed
  - Inventory correct
  - Potential Impact results correct
  - Impact results correct
  - Previous „inspections“
- For the life cycle links (i.e., market):
  - Rules followed
  - Markets correct
  - Previous „inspections“

Conclusion, 2

- CLCA is model sophistication, applying CLCA today seems rather a matter of being a fan or a believer
- This is despite often, CLCA promises to better address an LCA question
- Validation appears to be a way forward for improving the reliability of CLCA models, and make them more broadly used.
- For the effort, generic databases could help, but there can hardly be one „one size fits all“ generic database for all CLCA models
- This needs to be further explored.

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Thank you!

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