
DTU

AESA of long-lived systems: Time-related challenges and outlook

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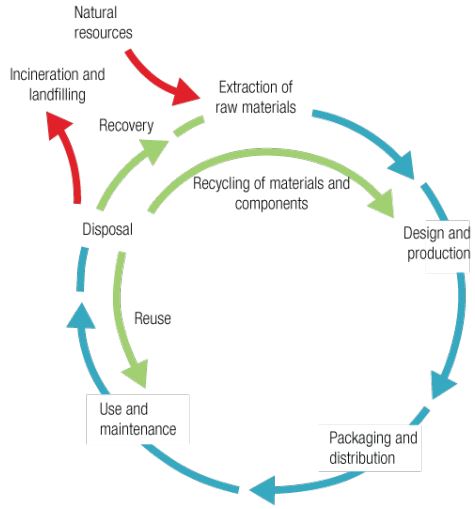
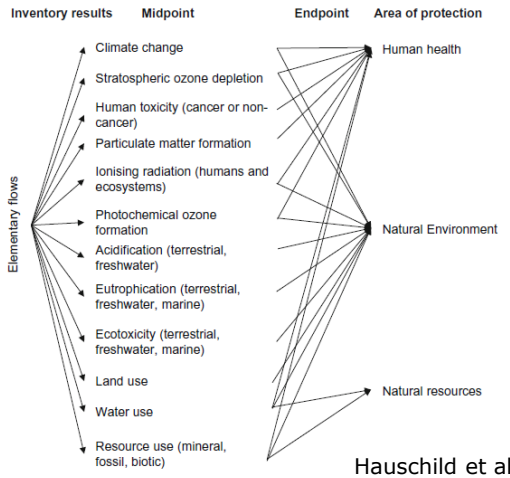
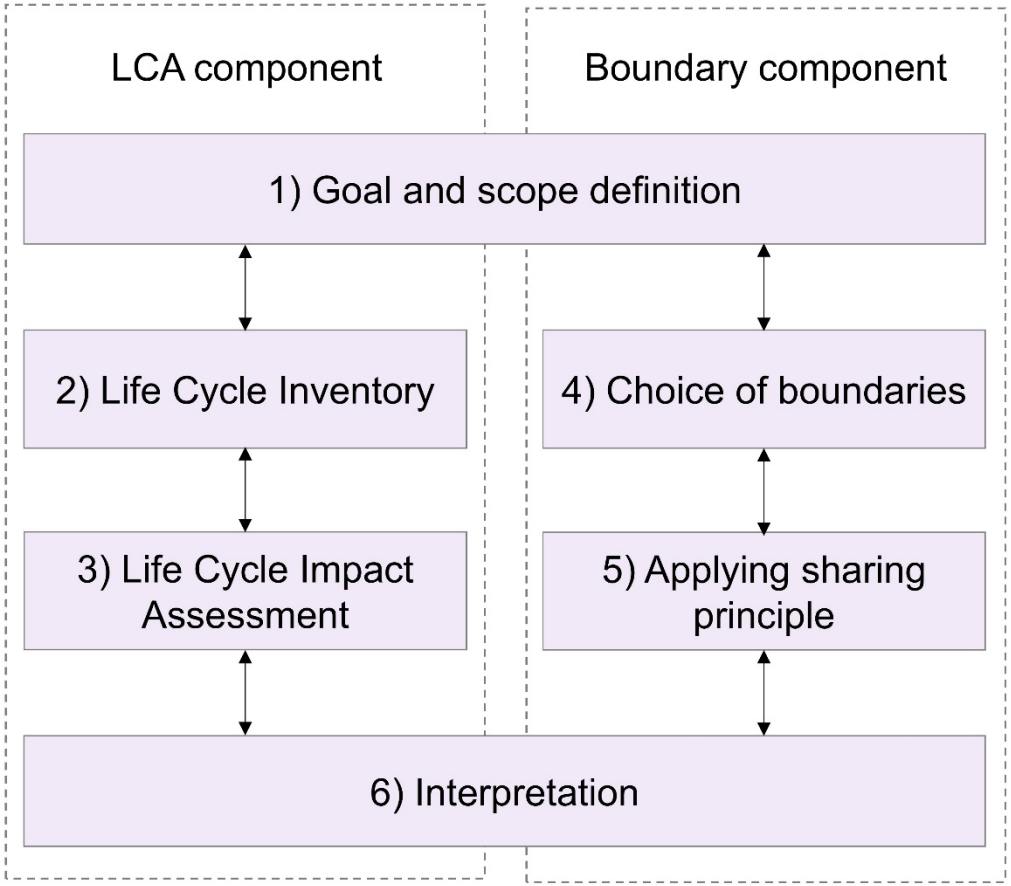
Absolute Environmental Sustainability Assessment (AESA)

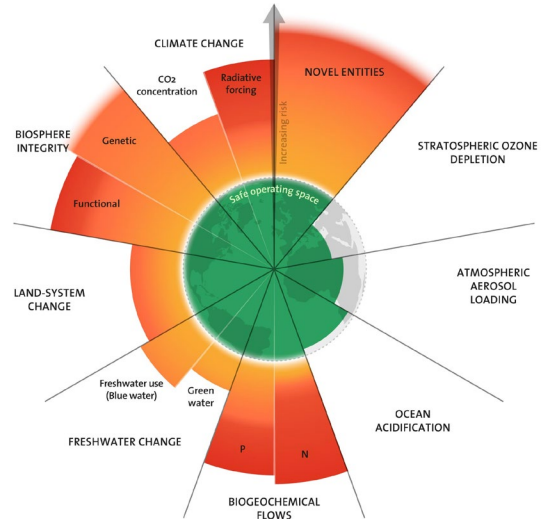


https://www.lifecycleinitiative.org/



Hauschild et al., 2018

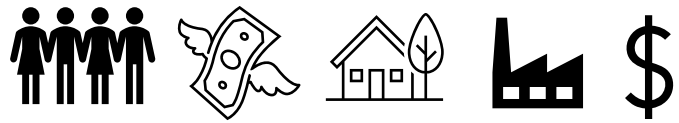




https://www.stockholmresilience.org

Simple example:

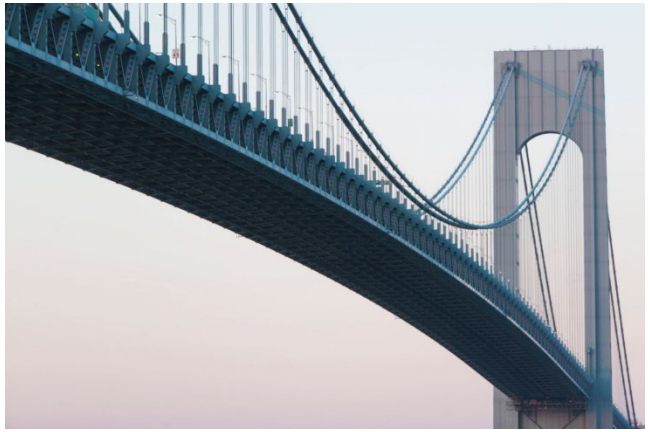
$$PB * \frac{population_{DK}}{population_{world}} * \frac{spending_{housing,DK}}{spending_{total,DK}}$$



AESA of long-lived systems

Common practice in building LCA/AESA:

- Average impacts per year over lifetime
- Often based on average current conditions (with the occasional exception of energy)



Problematic because

- Continuous emissions throughout lifetime
- Consequences of changes in the environment, technology and society over time

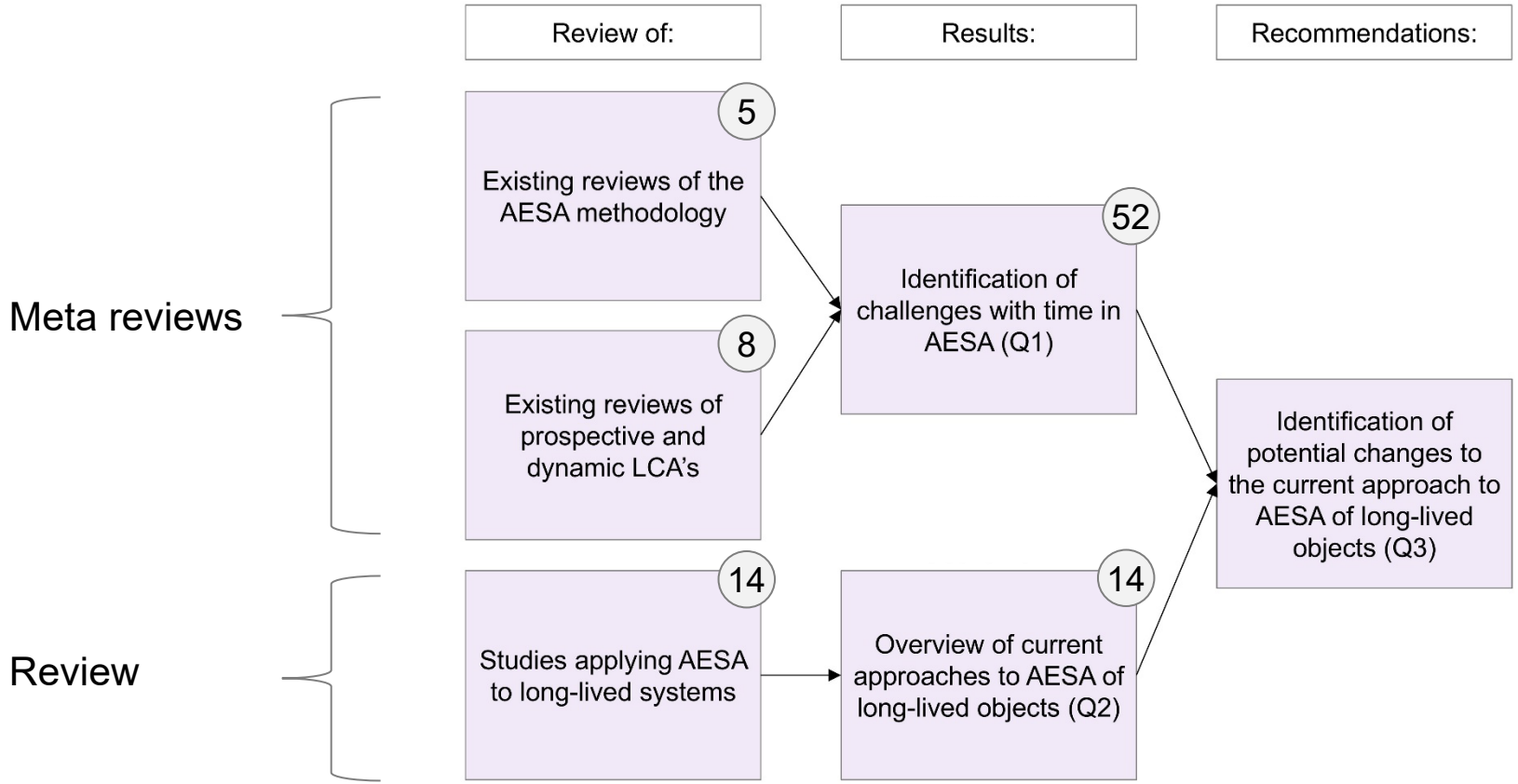
Research questions

1. What time-related challenges have previously been identified for the different phases of LCA and AESA?

2. What are the current approaches to AESA of long-lived systems and under what circumstances are they not suitable?

3. How can the representation of time in AESA of long-lived systems be improved?

Method


Review of:
Results:
Recommendations:
Meta reviews
Review
5
Existing reviews of the AESA methodology
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Existing reviews of prospective and dynamic LCA's
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Studies applying AESA to long-lived systems
52
Identification of challenges with time in AESA (Q1)
14
Overview of current approaches to AESA of long-lived objects (Q2)
Identification of potential changes to the current approach to AESA of long-lived objects (Q3)

From meta review: Challenges: the LCA component

LCI

- Generally, more advanced on the time than other phases (through DLCA and pLCA)
- Uncertainties with prediction of future and estimating lifetimes
- Often either prospective foreground or background only

LCIA

- Less advanced compared to LCI
- Very few dynamic and/or prospective CFs exist
- Missing link btw inventory and CFs in prospective/dynamic assessments
- Often modelled by “silo approach”, not including dynamics/interactions

From meta review: Challenges: the boundary component

Choice of boundaries:

- Dynamic choices mainly available for climate change
- Dynamic boundaries: lack impact categories other than climate change
- Like CFs, tend to exclude ecosystem interactions

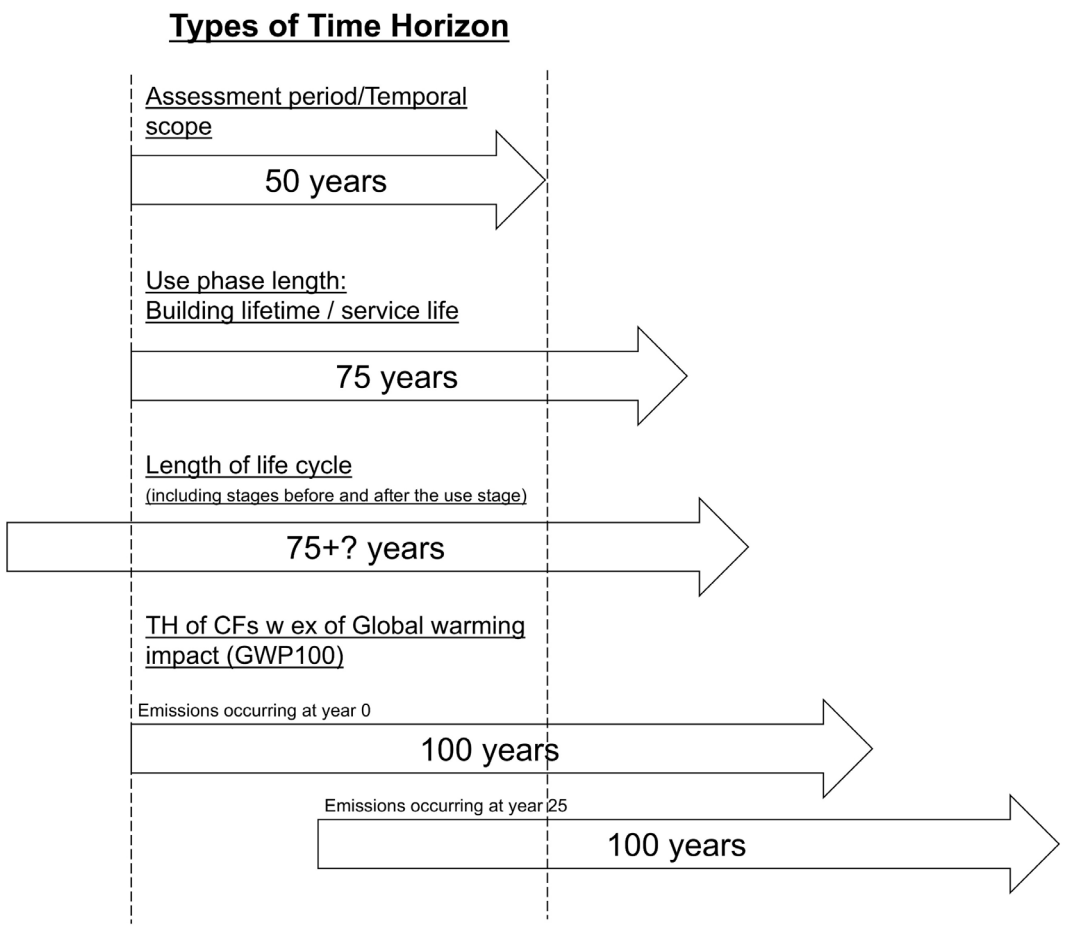
Sharing the boundaries:

- Common to use “status quo” approaches (ref year)
  - Trying to assess sustainability with non-sustainable conditions

From review: Overview of current approaches to AESA of long-lived systems

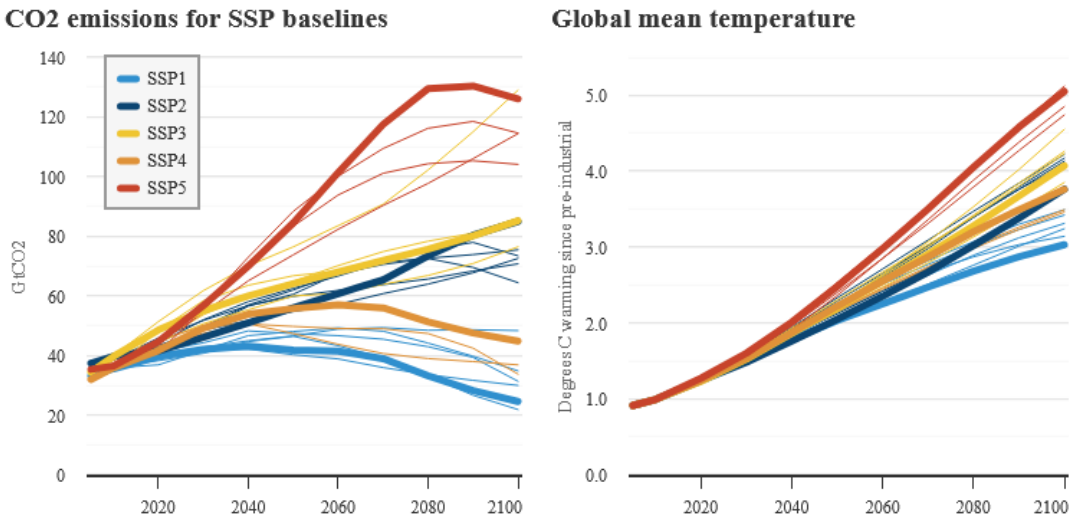
Source	Case groups	Lifetime/ assessment period	FU	LCI	LCIA	Boundary approach	Sharing data	Coverage of impact categories (amount)
Andersen et al., 2022	single building	50 / 50	Service life of 50 years	no	no	no	no	5
Andersen et al., 2020	single building	120–150 / 120–150	Annual housing	partly	no	no	no	8
Brejnrod et al., 2017	single building	50 and 120 / 50 and 120	Service life of 50 years	no	no	no	no	11
Chandrakumar et al., 2020	Built environment	90 / 32	Service life of 90 years	partly	no	partly	partly	1
Bullen et al., 2021	Built environment	60 / 32	No FU	partly	no	partly	partly	1
Baabou et al., 2022	Material flow	52 and 77 / 52 and 77	No FU	yes	yes	yes	no	1
Ohms et al., 2019	single building	120 and 150 / 120 and 120	Annual housing	partly	no	no	no	1
McLaren et al., 2020	Built environment	90 / 32	Service life of 90 years	partly	no	partly	partly	1
Kara et al., 2023	Material flow	- / 30	No FU	partly	no	yes	no	1
Olgyay and Herdt, 2004	Single building	Not clear	No FU	no	no	no	no	1
Ayoub et al., 2020	Material flow	- / 30	No FU	partly	no	partly	no	1
Schweitzer et al., 2023	Built environment	- / short term: 10, Long term: 25	No FU	partly	no	yes	partly	1
Bendewald et al., 2013	Single building	100 / 100	No FU	no	no	no	no	1
Heide et al., 2023	Single building	50 / 50	Service life of 50 years	partly	no	yes	no	1

Future research directions and recommendations



Clausen et al. (2025)

- More consistency in time horizons (both in terms of terminology and methodology/application)
- Increasing use of future scenarios in all phases (e.g., SSPs and RCPs)



www.carbonbrief.org

Inventory

- Consistently apply future scenarios through pLCA in AESA of long-lived products
- Include prospective aspects in both foreground and background

Impact assessment

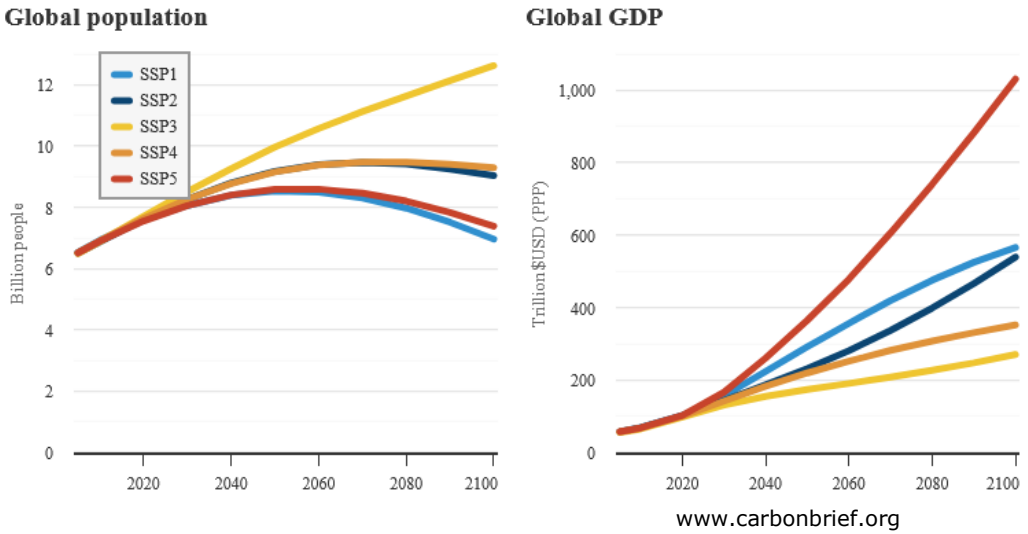
- Development of more prospective CFs
  - Changing response to emissions over time
  - Interactions in ecosystem over time
- Differences in impact time span = different temporal resolutions may be needed

Boundaries

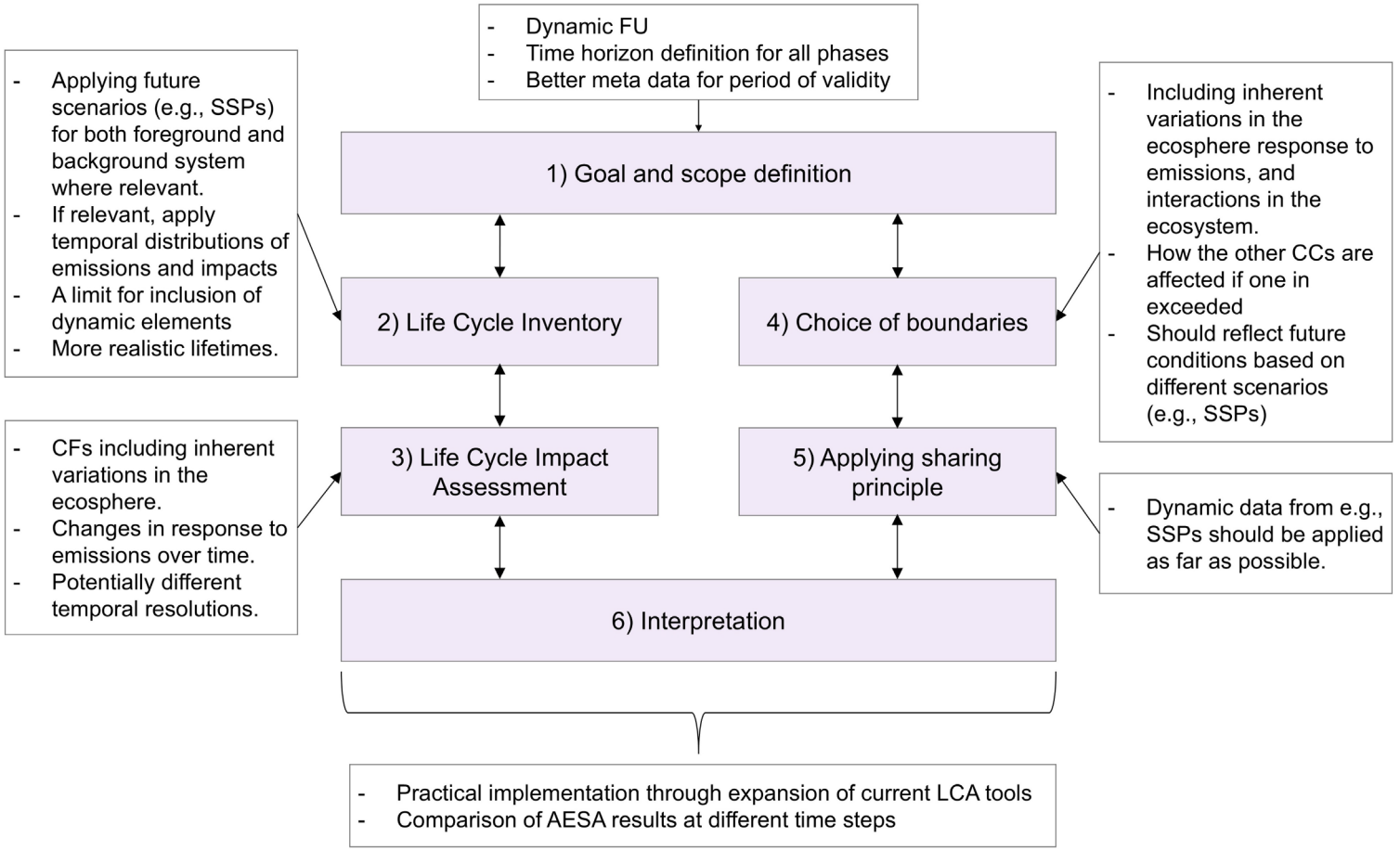
- To a large extend, the same mechanisms are applicable as in LCIA
- Include prospective/dynamic boundaries
  - Changes of response to emission
  - Interactions in ecosystem over time
- Effects of exceedance
  - E.g., climate change effect on water

Sharing the boundaries

- Include dynamic and/or prospective data from SSPs



More in paper



Thank you – Questions

Absolute environmental sustainability assessments of long-lived systems: A review of challenges with the representation of time and future research directions.

Caroline Amalie Clausen, Michael Hauschild & Anders Bjørn (2025).

Sustainable Production and Consumption, *58*, 140–150.
https://doi.org/10.1016/j.spc.2025.06.006