STATUS AND CURRENT ISSUES FROM THE ACADEMIA

HARPA BIRGISDOTTIR

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HARMONIZATION

LCA of buildings - Calculation methods and benchmarks

- European and international standards in place and constantly under development

- Still there is a room for **different approaches** within the standards
  - **System boundaries**,
  - **Data** for building materials depending on databases used
  - **Methods**, such as forecasting of energy-use etc.

- And therefore **different results** are achieved – and can not always (or seldom) be compared across countries

International (and Nordic) harmonization

International Energy Agency

EBC
Energy in Buildings and Communities Programme

EBC ANNEX 57
Evaluation of Embodied Energy and CO2 Equivalent Emissions for Building Construction

Status: Completed (2011 - 2016)

IEA EBC Annex 72 - Assessing Life Cycle Related Environmental Impacts Caused by Buildings

Status: Ongoing (2016 – 2021/22)

And here we are within research looking into:

- Challenges
- Barriers
- Solutions

Embodied impacts are important – but methods differ

Energy and Buildings
Volume 154, 1 November 2017, Pages 72-80

Replication Studies paper

IEA EBC annex 57 'evaluation of embodied energy and CO_{2eq} for building construction'

H. Birgisdottir [a], A. Moncaster [b], A. Houlihan Wiberg [c], C. Chae [d], K. Yokoyama [e], M. Balouktsi [f], S. Seo [g], T. Oka [h], T. Lützkendorf [f], T. Malmqvist [i]

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https://doi.org/10.1016/j.enbuild.2017.08.030

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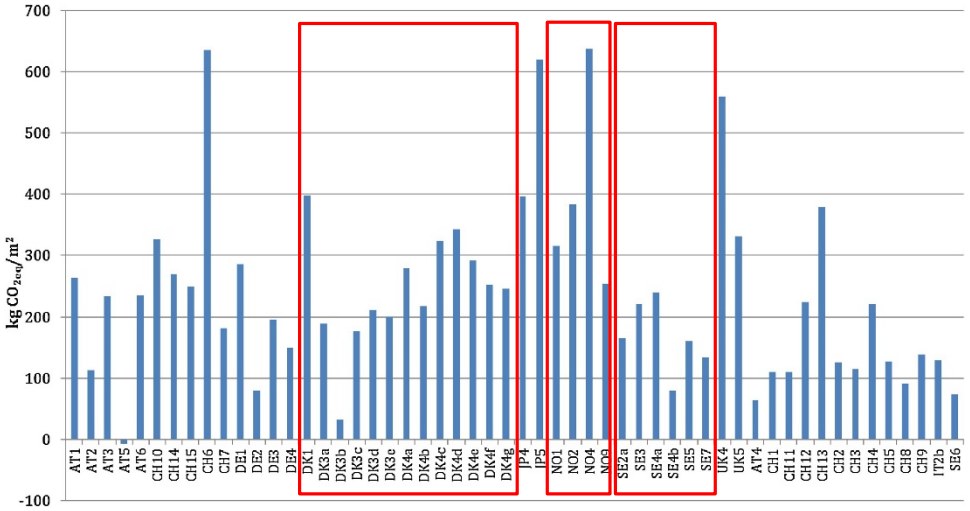
Highlights

- Building-related embodied impacts are growing and should not be ignored.
- Ways of improving transparency in embodied impact assessments are proposed.
- Actor-specific guidelines can foster integration of embodied impacts into practice.
- The availability of quality-checked databases can support the entire process.



Annex 57

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Methodological choices influence the results

Energy and Buildings
Volume 158, 1 January 2018, Pages 1487-1498

Analysing methodological choices in calculations of embodied energy and GHG emissions from buildings

Freja Nygaard Rasmussen [a], Tove Malmqvist [b], Alice Moncaster [c], Aoife Houlihan Wiberg [d], Harpa Birgisdóttir [a]

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https://doi.org/10.1016/j.enbuild.2017.11.013

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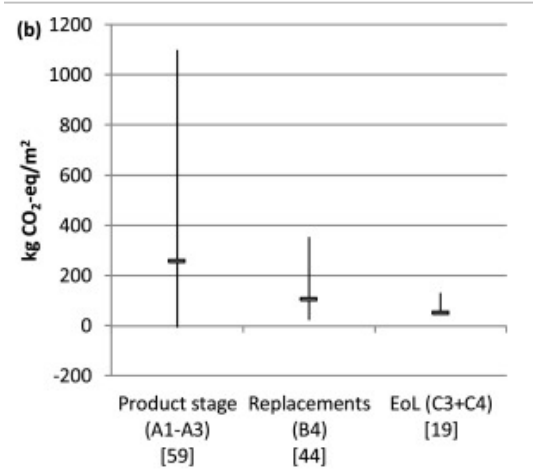
Highlights

- Methodological choices profoundly influences numerical results of embodied energy and GHG emissions of buildings.
- Each step in the assessment practice contains methodological choices of relevance to results.
- A systematic overview of the methodological issues of concern ensures informed use of existing and new studies.



Annex 57

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Design and construction strategies potential for reduction

Energy and Buildings
Volume 166, 1 May 2018, Pages 35-47

Design and construction strategies for reducing embodied impacts from buildings – Case study analysis

Tove Malmqvist [a], Marie Nehasilova [b], Alice Moncaster [c], Harpa Birgisdottir [d], Freja Nygaard Rasmussen [d], Aoife Houlihan Wiberg [e], José Potting [a]

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https://doi.org/10.1016/j.enbuild.2018.01.033

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Highlights

- Analysis of a large number of case studies.
- There is considerable potential to reduce embodied impacts in the design and construction of buildings.
- All building process actors can find reduction strategies in which to engage.
- Design and construction strategies to reduce EEG build on substituting materials and reducing material use.

Design strategi: comparing timber with….

Case study	EEG system boundary (see Fig. 1)	Level of building inventory	Timber is replacing...	EG reduction	EE reduction
At least load-bearing structure is replaced with wood (sometimes also foundations and non-load bearing structures					
UK5	Cradle-to-handover	Excl. building services, internal walls/doors/fittings and finishes	Masonry	34%	26%
UK7	Cradle-to-handover	Main structural elements	Steel	30%	1%
UK9	Cradle-to-handover	Main structural elements + elements affected by the choice of structural solution	Concrete	39%	Not studied
SE2b	Cradle-to-gate	Main building elements, both load-bearing and non-load bearing parts	Concrete	77%	Not studied
SE3	Cradle-to-gate		Concrete	27%	Not studied
SE4	Cradle-to-gate		Concrete	67%	Not studied
SE5	Cradle-to-gate		Concrete	28%	Not studied
Façade material is replaced with wood					
UK5	Cradle-to-gate	See above	Bricks	24%	26%
SE7	Cradle-to-grave	All components	Concrete	15%	Not studied

Annex 57

Embodied impacts are important – and timing matters

Applied Energy
Volume 258, 15 January 2020, 114107

Embodied GHG emissions of buildings – The hidden challenge for effective climate change mitigation ☆

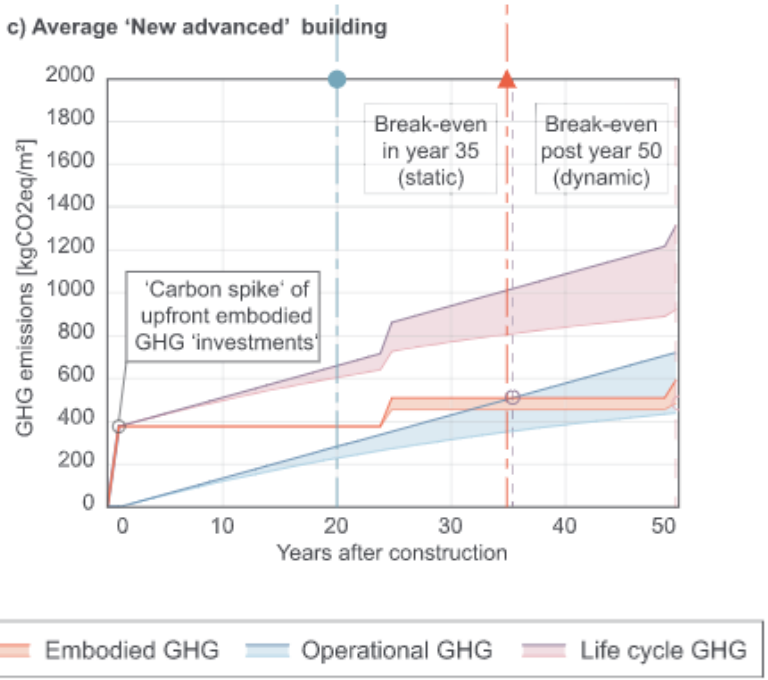
Martin Röck [a] ✉, Marcella Ruschi Mendes Saade [b], Maria Balouktsi [c], Freja Nygaard Rasmussen [d], Harpa Birgisdottir [d], Rolf Frischknecht [e], Guillaume Habert [f], Thomas Lützkendorf [c], Alexander Passer [a] ✉

Show more

https://doi.org/10.1016/j.apenergy.2019.114107

Highlights

- Systematic analysis of 650+ building LCA cases on life cycle greenhouse gas emissions.
- Buildings life cycle GHG emissions are reducing due to energy efficiency improvements.
- Meanwhile, embodied GHG emissions increased and are now dominating the life cycle.
- New building upfront GHG investments dominate timeframe for



Annex 72

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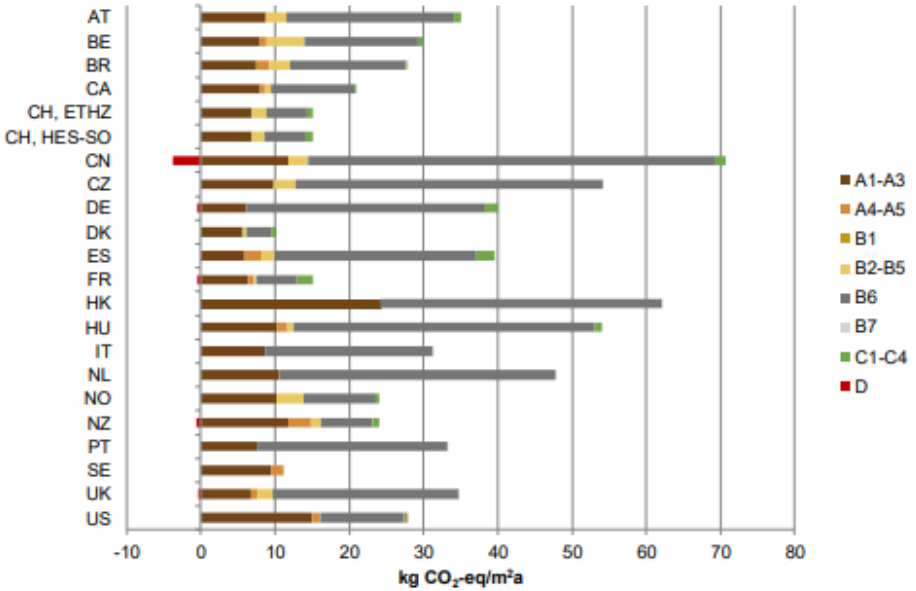
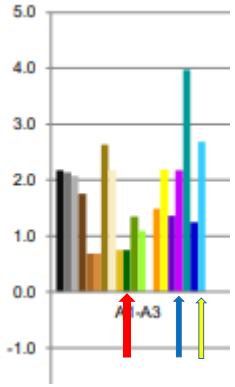
Comparison of the environmental assessment of an identical office building with national methods

be2226: Austria

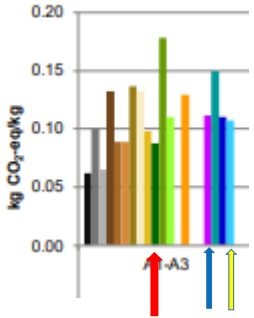


Differences in data used within the Nordic countries

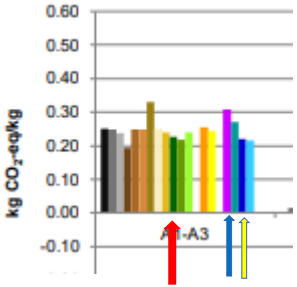
Reinforcement steel



Concrete



Bricks



AT BE BR CA CH_ETHZ CH_HES_SO CN CZ DE DK ES FR HK HU IT NL NO NZ PT SE UK US

Important package

Within each country

- Consistent methodological description
- Data-package
- Tools available

- Consistent methodological description
- Data-package
- Tools available

Etc.

If harmonized Nordic

- Consistent methodological description
- Data-package
- Tools available

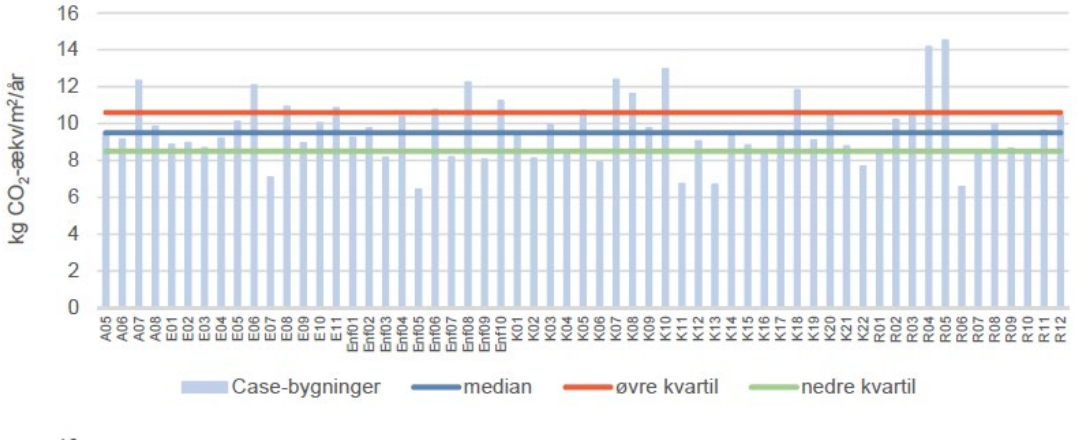
REDUCTION POTENTIAL

Climate impact and reduction potential

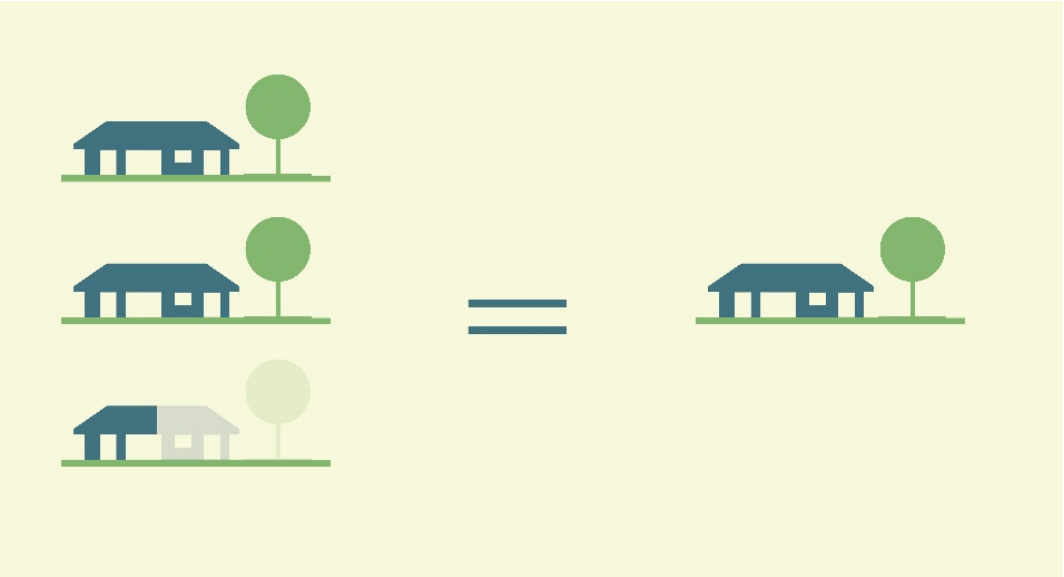
SBI 2020:04

Klimapåvirkning fra 60 bygninger

Muligheder for udformning af referenceværdier til LCA for bygninger



Reduction potential



Bringing this into building regulation in the future will probably (and hopefully) have a big potential for reduction

CARBON BUDGET

Earth capacity and planetary boundaries

Focus on our carbon budget

(and not ”only” if we are
10 or 20 % better than
last year buildings)

- 70% reduction in 2030 according to Danish political goals
- ‘net zero’ in 2050 in order to stay below 1.5°C (IPCC)
- Decarbonized buildings in 2050 (EU through EPBD)

Carbon budgets

BUILDINGS & CITIES

Habert, G., et al. (2020). Carbon budgets for buildings: harmonising temporal, spatial and sectoral dimensions. *Buildings and Cities*, 1(1), pp. 429-452. DOI: https://doi.org/10.5334/bc.47

SYNTHESIS

Carbon budgets for buildings: harmonising temporal, spatial and sectoral dimensions

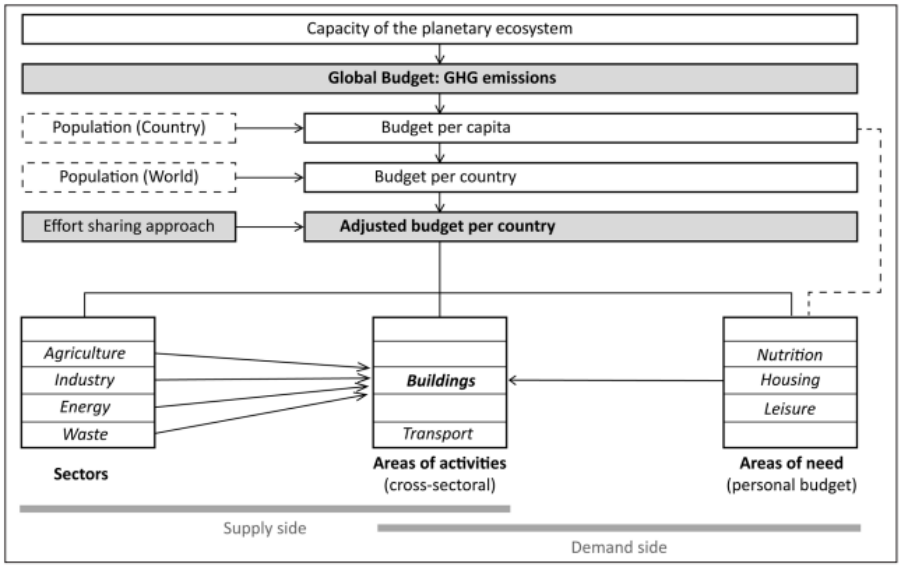
Guillaume Habert[1], Martin Röck[2], Karl Steininger[3], Antonin Lupísek[4], Harpa Birgisdottir[5], Harald Desing[6], Chanjief Chandrakumar[7], Francesco Pittau,[8] Alexander Passer[9], Ronald Rovers[10], Katarina Slavkovic[11], Alexander Hollberg[12], Endrit Hoxha[13], Thomas Jusselme[14], Emilie Nault[15], Karen Allacker[16] and Thomas Lützkendorf[17]

Abstract

Target values for creating carbon budgets for buildings are important for developing climate-neutral building stocks. A lack of clarity currently exists for defining carbon budgets for buildings and what constitutes a unit of assessment—particularly the distinction between production- and consumption-based accounting. These different perspectives on the system and the function that is assessed hinder a clear and commonly agreed definition of 'carbon budgets' for building construction and operation. This paper explores the processes for establishing a carbon budget for residential and non-residential buildings. A detailed review of current approaches to budget allocation is presented. The temporal and spatial scales of evaluation are considered as well as the distribution rules for sharing the budget between parties or activities. This analysis highlights the crucial need to define the temporal scale, the roles of buildings as physical artefacts and their economic activities. A framework is proposed to accommodate these different perspectives and spatio-temporal scales towards harmonised and comparable cross-sectoral budget definitions.

Policy relevance

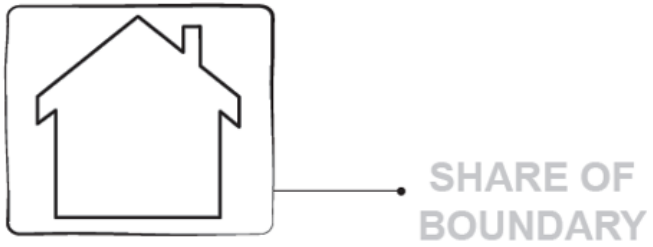
The potential to develop, implement and monitor greenhouse gas-related policies and strategies for buildings will depend on the provision of clear targets. Based on global limits, a carbon budget can establish system boundaries and scalable targets. An operational framework is presented that clarifies greenhouse gas targets for buildings in the different parts of the world that is adaptable to the context and circumstances of a particular place. A carbon budget can enable national regulators to set feasible and legally binding requirements. This will assist the many different stakeholders responsible for decisions on buildings to coordinate and incorporate their specific responsibility at one specific level or scale of activity to ensure overall compliance. Therefore, determining a task specific carbon budget requires an appropriate management of the global carbon budget to ensure that specific budgets overlap, but that the sum of them is equal to the available global budget without double-counting.



Assessing absolute sustainability

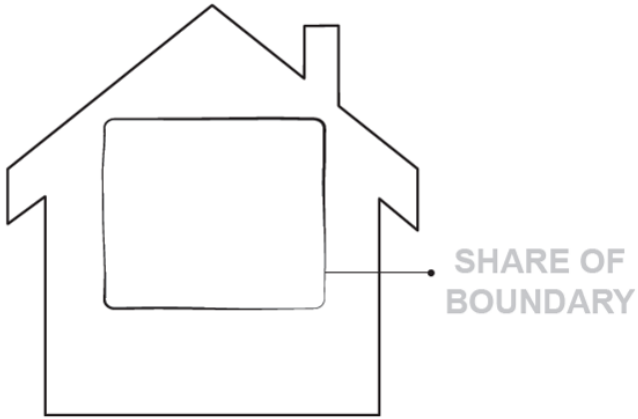
- Is the environmental impact of the building smaller or larger than the allocated share of the relevant boundary?

- If it is smaller – the building is absolute environmentally sustainable!

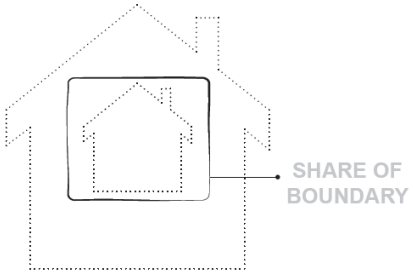


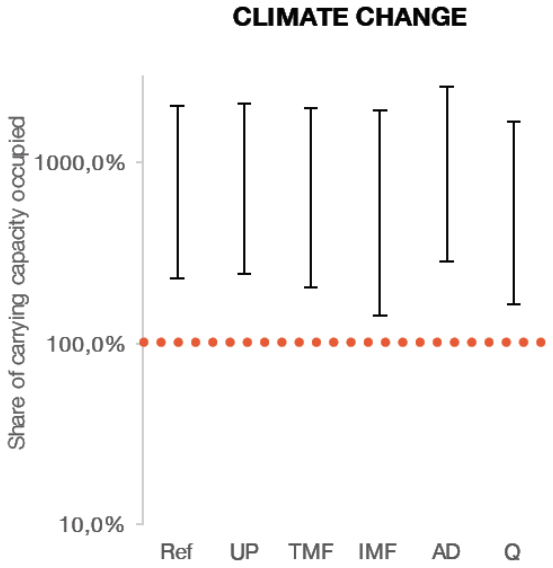
Assessing absolute sustainability

- Is the environmental impact of the building smaller or larger than the allocated share of the relevant boundary?
- If it is smaller – the building is absolute environmentally sustainable!
- If it is larger – the building is not absolute environmentally sustainable!



Absolute environmental sustainability – climate change





ELSEVIER

Building and Environment
Volume 171, 15 March 2020, 106633

Assessment of absolute environmental sustainability in the built environment

Camilla Ernst Andersen [a], Pernille Ohms [b], Freja Nygaard Rasmussen [a], Harpa Birgisdóttir [a], Morten Birkved [c], Michael Hauschild [b], Morten Ryberg [b]

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Thank you!