KYNNING

HARPA BIRGISDOTTIR

DANISH BUILDING RESEARCH INSTITUTE
AALBORG UNIVERSITY COPENHAGEN

Sjálfbærni bygginga

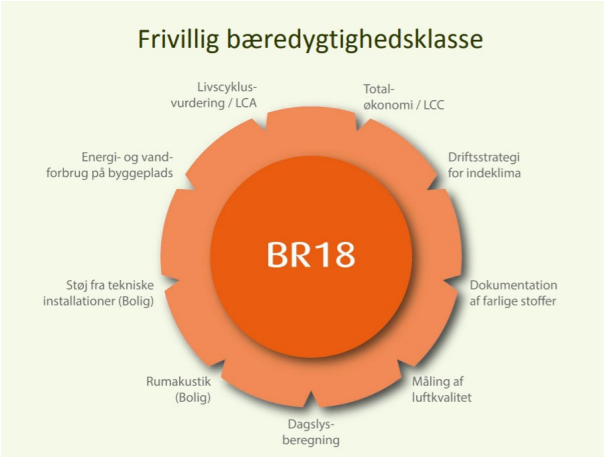
Samanburður á kerfum

Aðlögun að dönskum aðstæðum

GREEN BUILDING COUNCIL DENMARK

DGNB

Sjálfbærni í byggingarreglugerð



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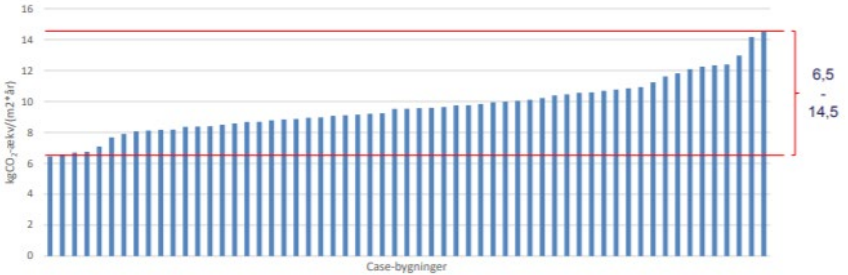
Level(s)

LCAbyg og ýmsar skýrslur



Hringrásarhagkerfi – Circular Economy

Potential of Circular Economy in Sustainable Buildings

Leonora Charlotte Malabi Eberhardt [1], Harpa Birgisdottir [1], Morten Birkved [2]

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[2] DTU Management Engineering, Technical University of Denmark, Produktionstorvet, Building 426, 2800 Kongens Lyngby, Denmark

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Circular Economy in the built environment using Life Cycle Assessment: a case study

Camilla Marlene Ernst Andersen, Kai Kanafani, Regitze Kjær Zimmermann, Freja Nygaard Rasmussen, Harpa Birgisdottir

Det Ingeniør- og Naturvidenskabelige Fakultet, Forskningsgruppen for Bygningers Bæredygtighed, Institut for Byggeri, By og Miljø, Sektionen for Bygningers Energieffektivitet, Indeklima og Bæredygtighed (EIB)

Circularity in the built environment: A call for a paradigm shift

Tove Malmqvist, Freja Nygaard Rasmussen, Alice Moncaster, Harpa Birgisdottir

Det Ingeniør- og Naturvidenskabelige Fakultet, Forskningsgruppen for Bygningers Bæredygtighed, Institut for Byggeri, By og Miljø, Sektionen for Bygningers Energieffektivitet, Indeklima og Bæredygtighed (EIB)

KOLEFNISSPOR BYGGINGA

EMBODIED CARBON IN BUILDINGS
AN IMPORTANT CLIMATE CHANGE ISSUE

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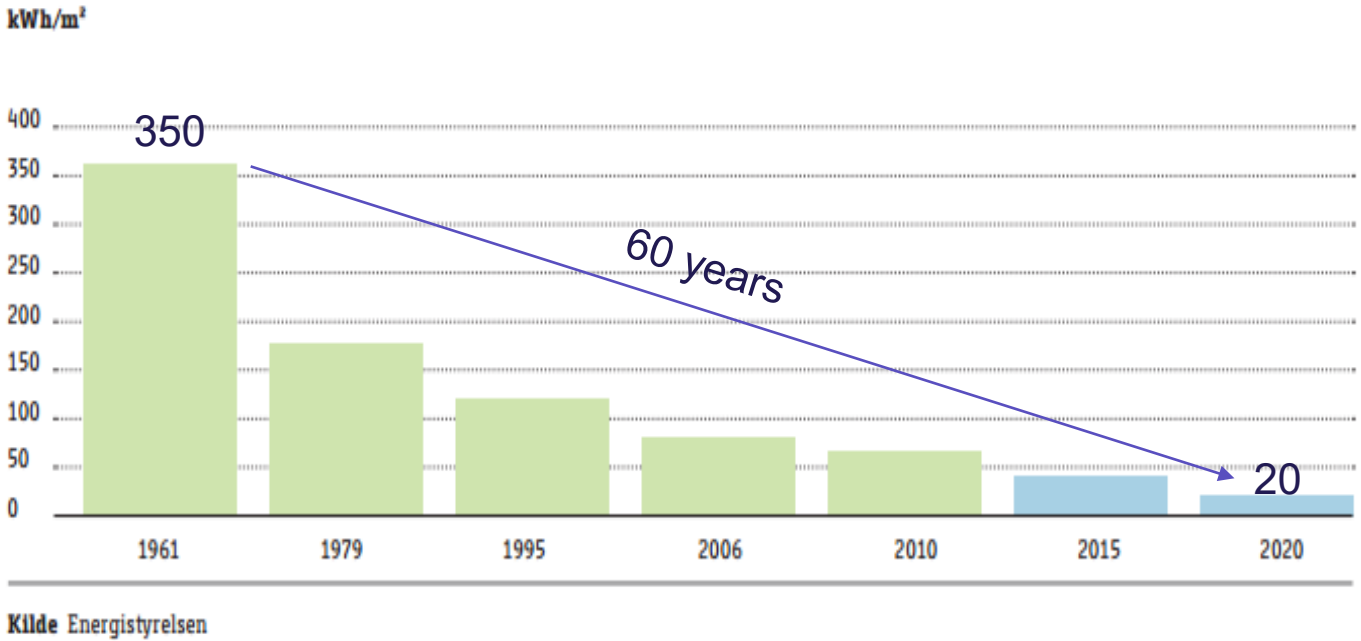
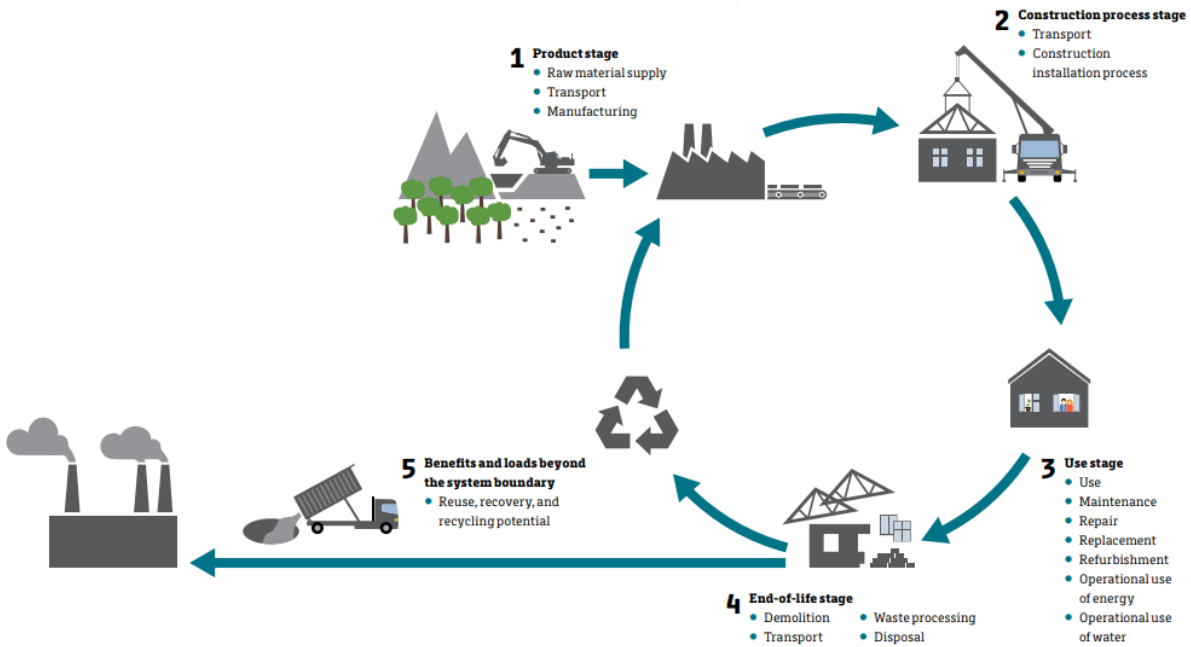
Development of the operational energy requirements

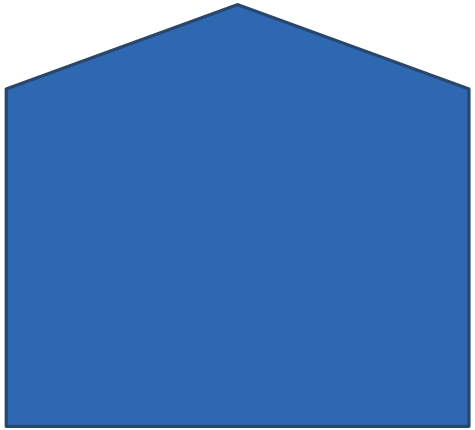


Focus on building life cycle



Whole life carbon assessment for buildings

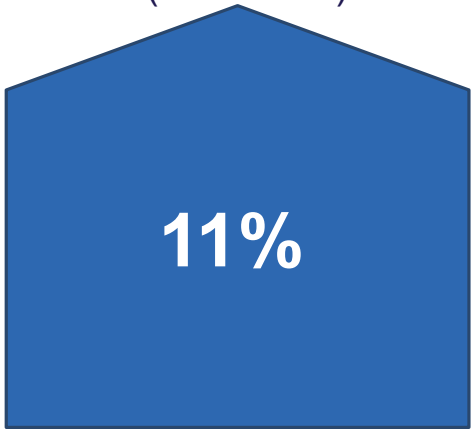
Emissions related to Building materials (Embodied)



Emissions related to Operational energy consumption

Greenhouse gas emissions related to built environment on global scale

Emissions related to materials for buildings and infrastructure (Embodied)



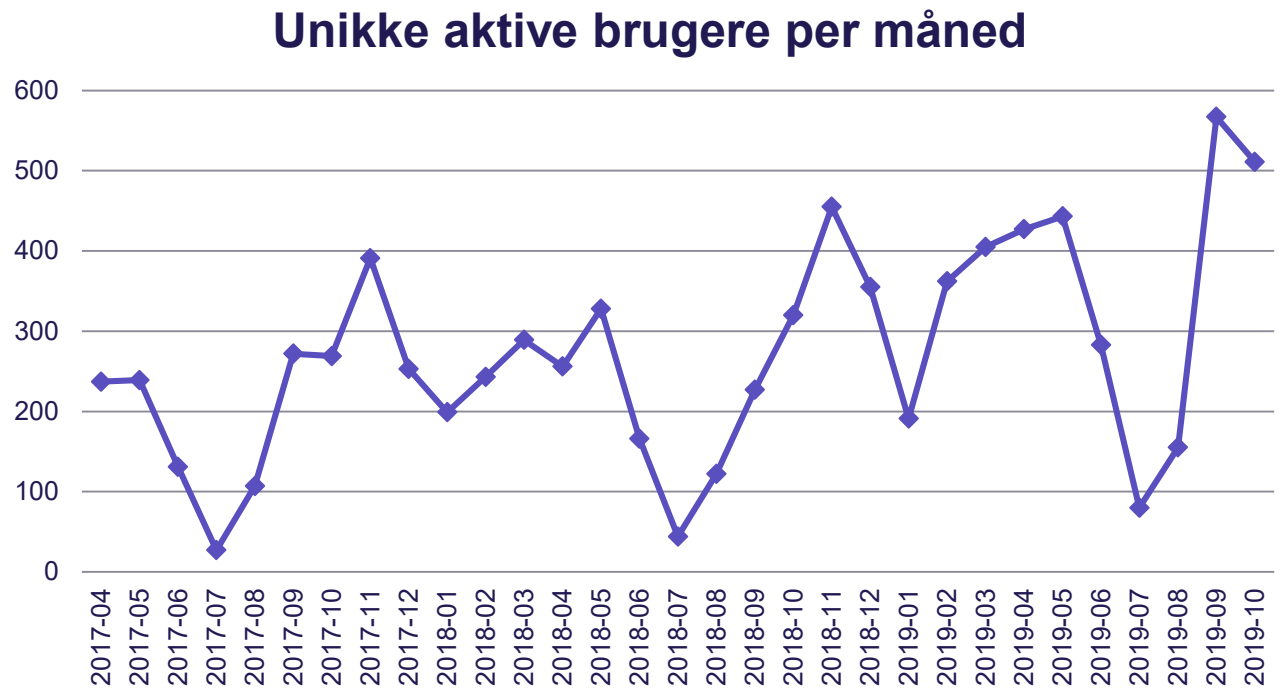
Emissions related to Operational energy consumption

Bringing embodied carbon upfront, WGBC 2019

LCAbyg

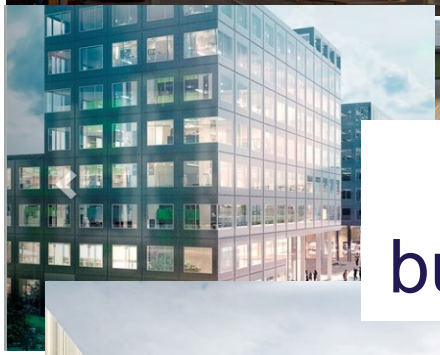
- Developed by The Danish Building Research Institute for the Danish Transport, Construction and Housing Authority
- National freely available tool developed for the Danish building sector
- First version launched in April 2015
- New beta version in January 2019 with focus on early design stages
- Over 3500 users, about 300-600 users each month

It is being used





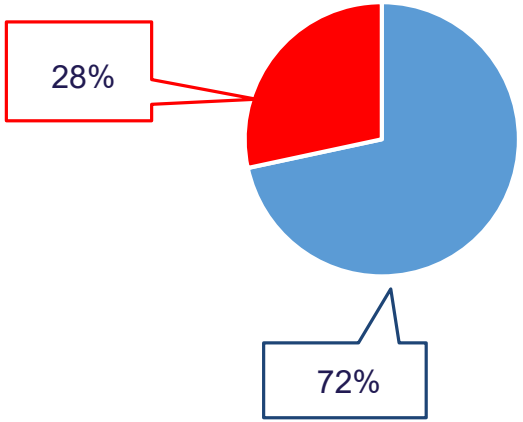


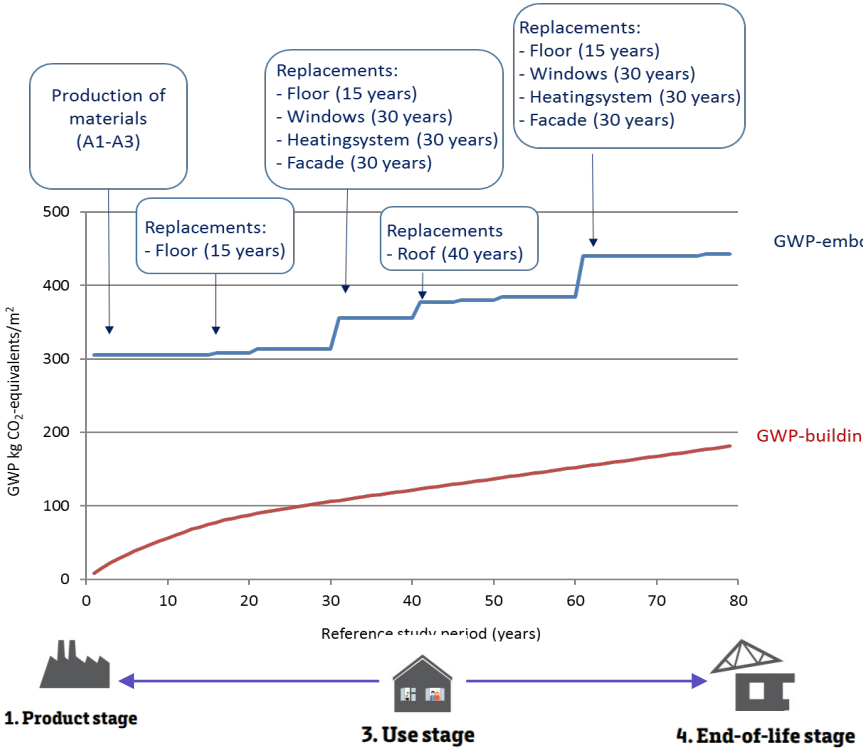



How does it look like for the buildings we are building today?




Whole life carbon assessment for an office building – an example

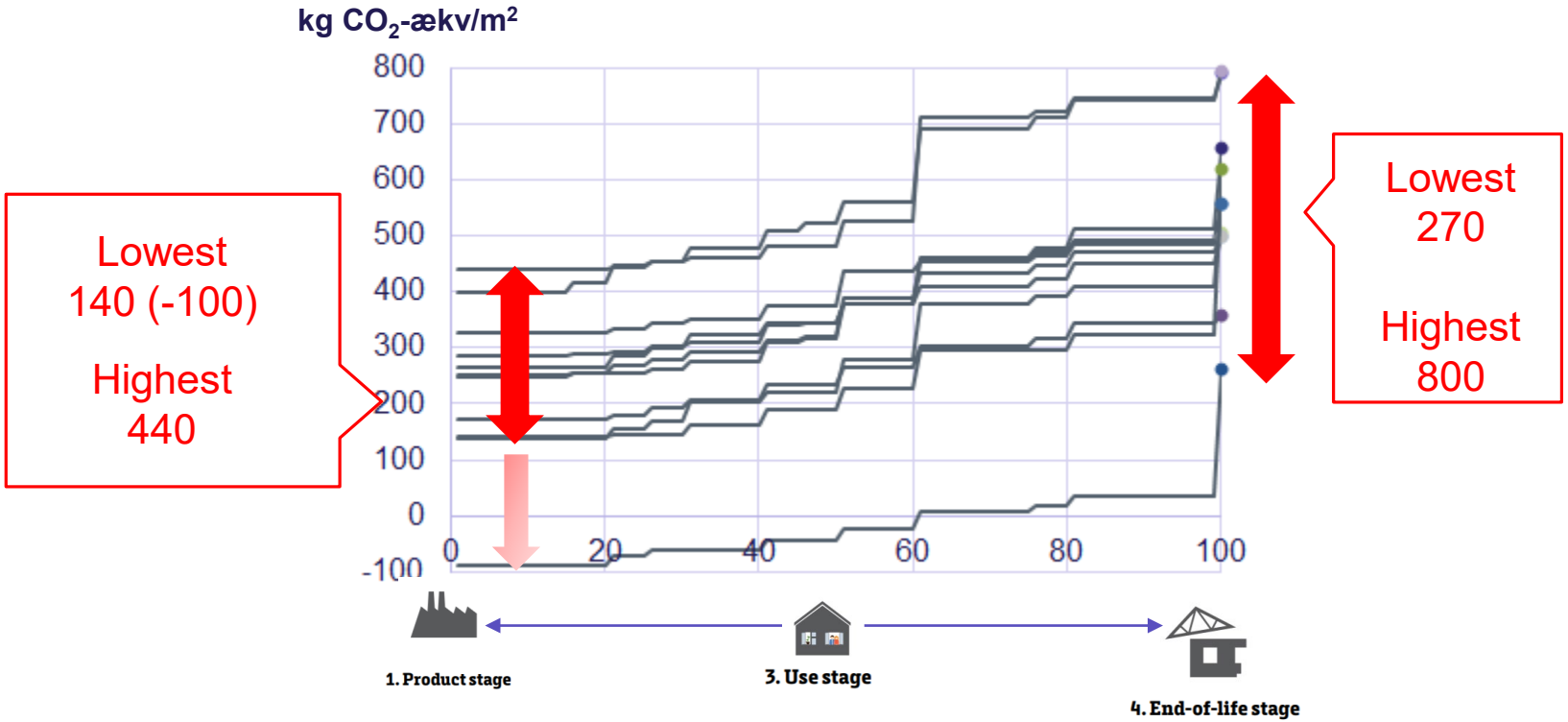




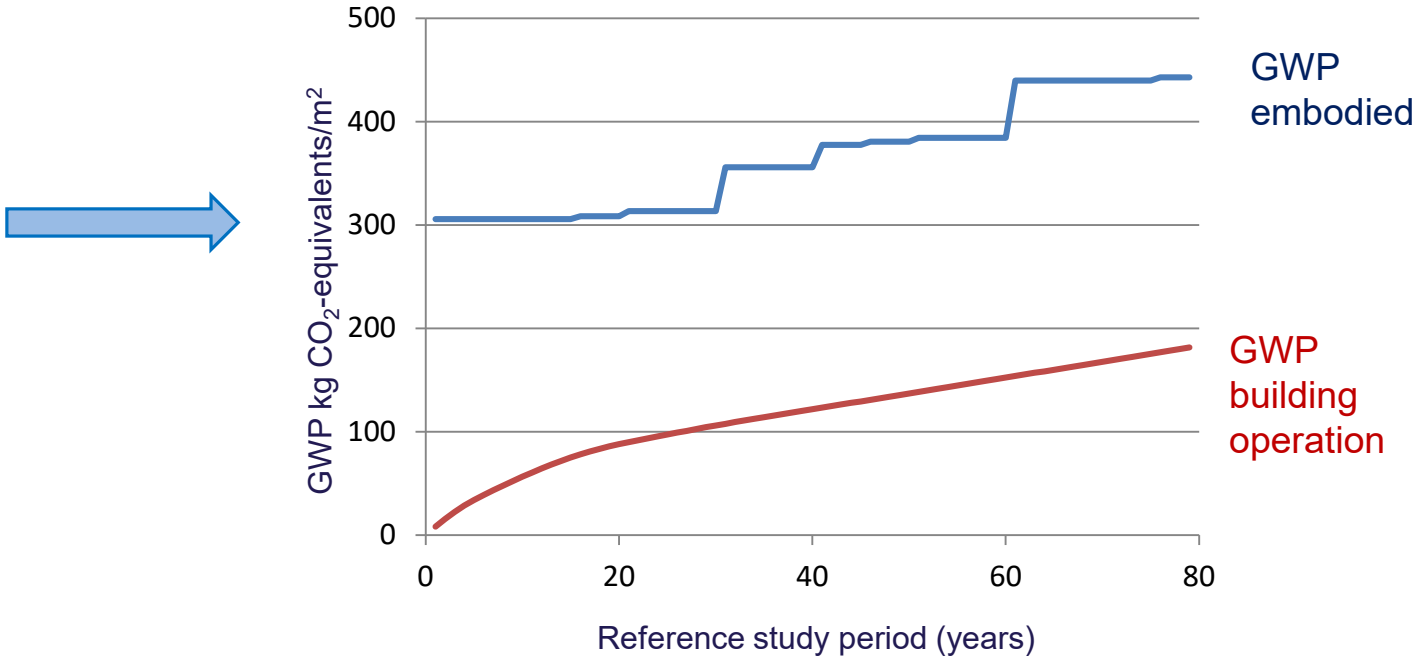
Not regulated

Regulated

There is a large potential to reduce the embodied impacts



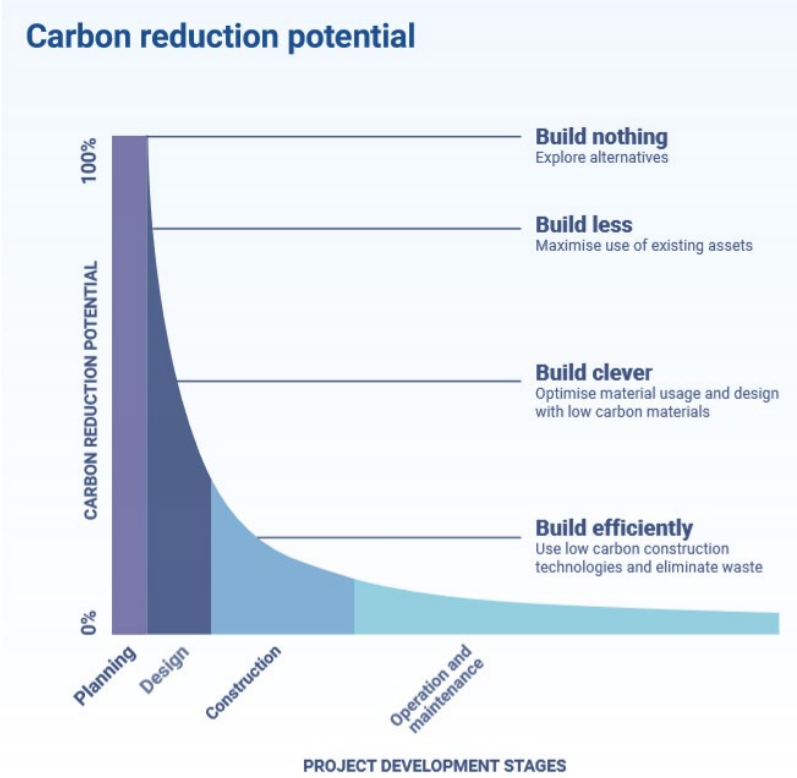
How can we reduce the embodied carbon of buildings?



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)



- The potential within the **existing buildings**: Renovation of existing buildings

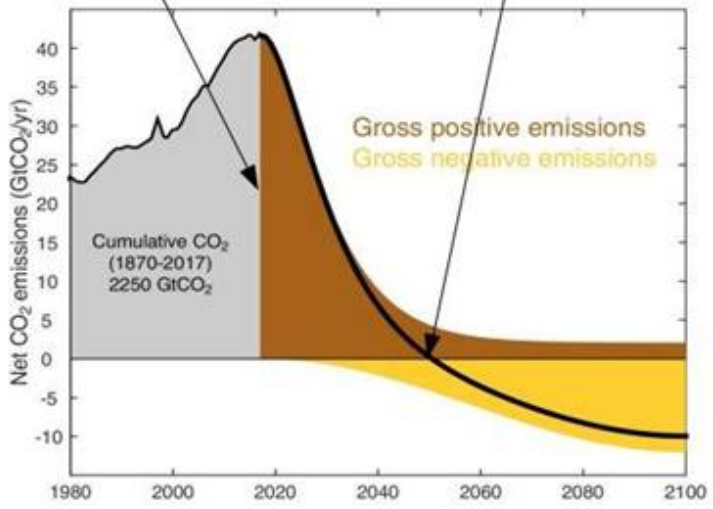
- The potential to reduce impacts of **new buildings**
  - Design strategies
  - Choice of materials
  - Circular economy strategies
  - ….
  - Size

HM Treasury: Infrastructure Carbon Review, 2013 i World GBC: Bringing embodied carbon upfront, 2019

Limited carbon budget left in order to stay below 1.5°C

This budget left, is needed to invest in reducing *existing (buildings)* emissions!

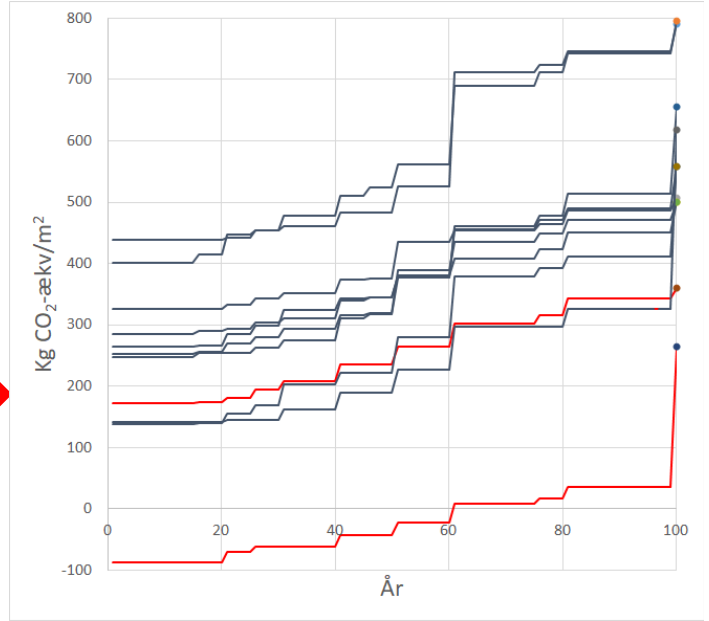
Therefor: New buildings should already comply with buiding regulations of 2050 !



Ronald Rovers, **www.ronaldrovers.com**

How can we reduce the embodied carbon of buildings?

- It is time to take some steps in the right direction
- Some big steps
- Identify the **drivers** and **solutions** that are necessary
  - to start building only these buildings from now on
  - to reach net zero emission buildings in 2050



HOW?

EBC
Energy in Buildings and Communities Programme

International Energy Agency

Strategies for Reducing Embodied Energy and Embodied GHG Emissions

Guideline for Designers and Consultants – Part 2

IEA EBC Annex 57

September 2016

iea Energy Technology Network

Energy & Buildings 166 (2018) 35–47

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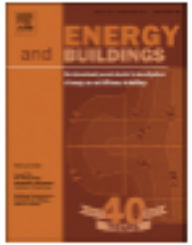
journal homepage: www.elsevier.com/locate/enbuild



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]

Design strategies for reducing embodied emissions

- **Substitution of materials**
  - Natural Materials for load bearing structures
  - Natural materials
  - Recycled & reused materials and components
  - Innovative materials
- **Reduction of resource use**
  - Light-weight constructions
  - Building form and design of layout plan
  - Design for flexibility and adaptability
  - Low maintenance and service life extension
  - Reuse of building structures
- **Reduction of construction stage impacts**
- **Design for low end of life impacts**
  - Design for low impact of end-of-life stage


Use of Wood?

Design strategies for reducing embodied emissions

- **Substitution of materials**
  - Natural Materials for load bearing structures
  - Natural materials
  - Recycled & reused materials and components
  - Innovative materials
- **Reduction of resource use**
  - Light-weight constructions
  - Building form and design of layout plan
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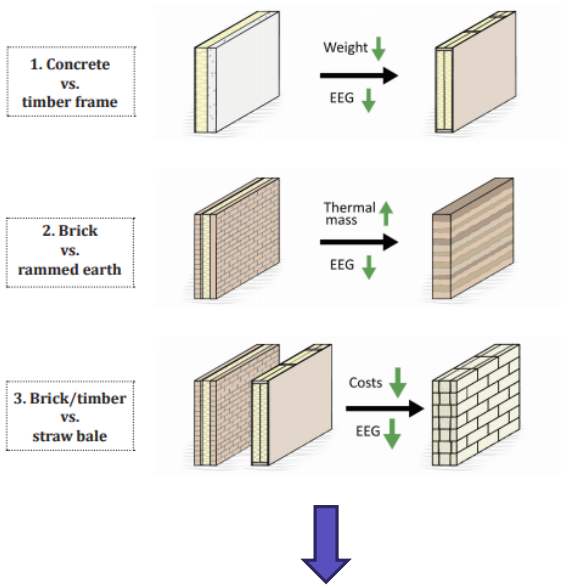
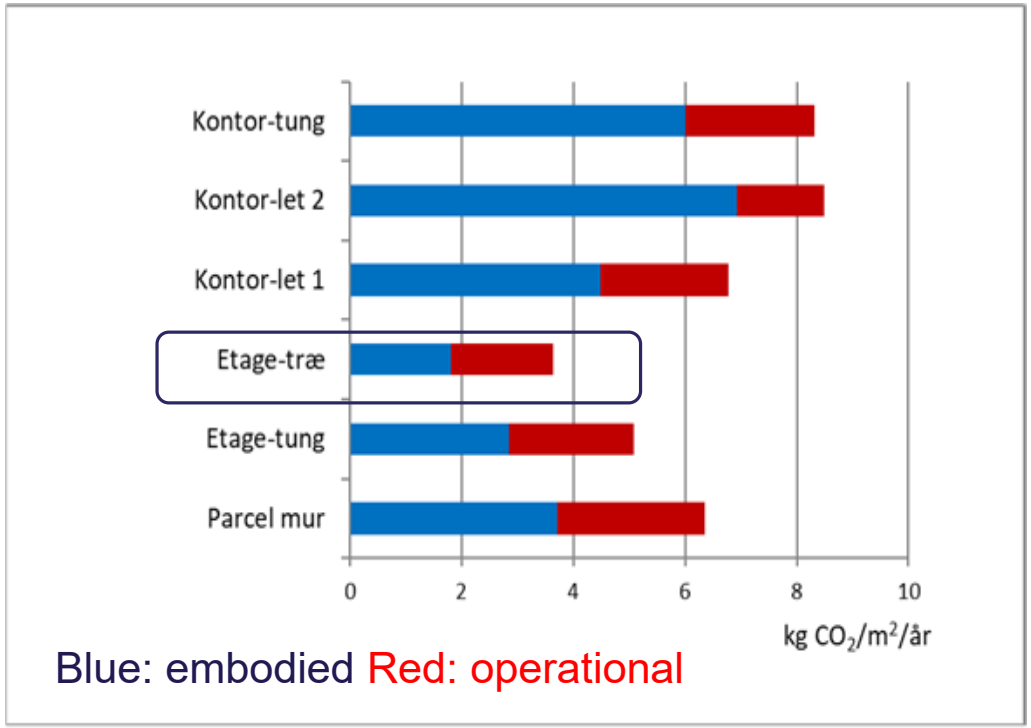


27-77% reduction compared to concrete, masonry and steel

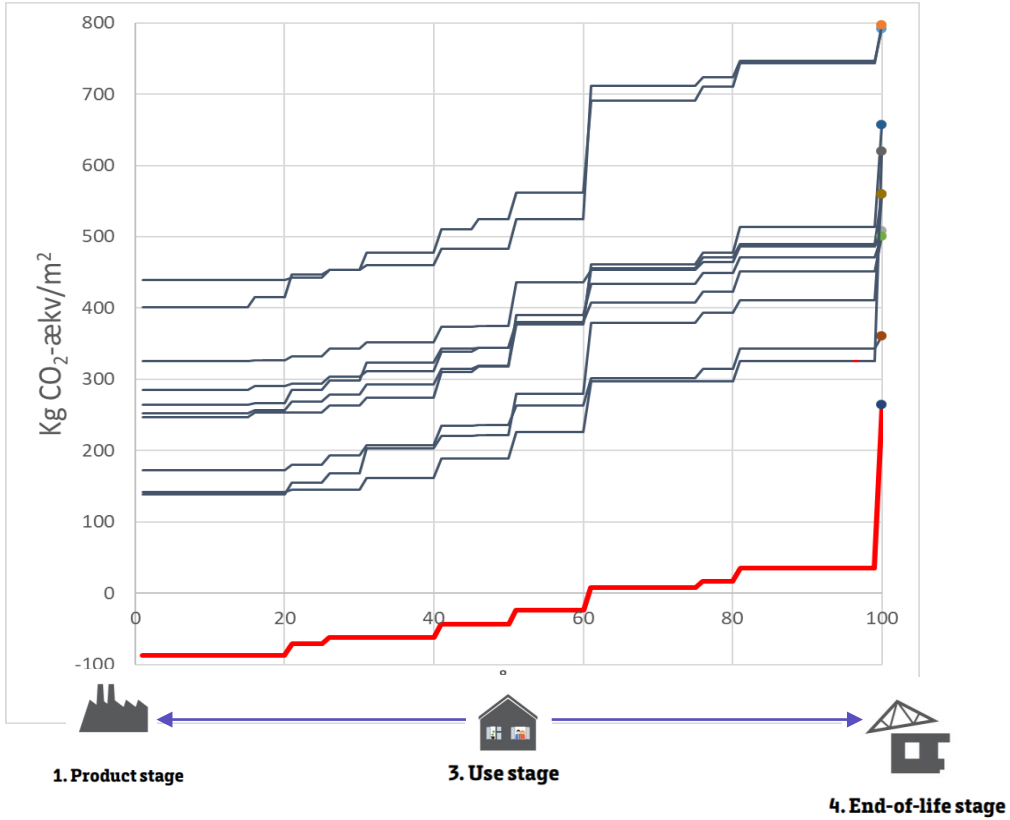
Supported by recent Danish cases (SBI 08:2017)



Offices
80 years

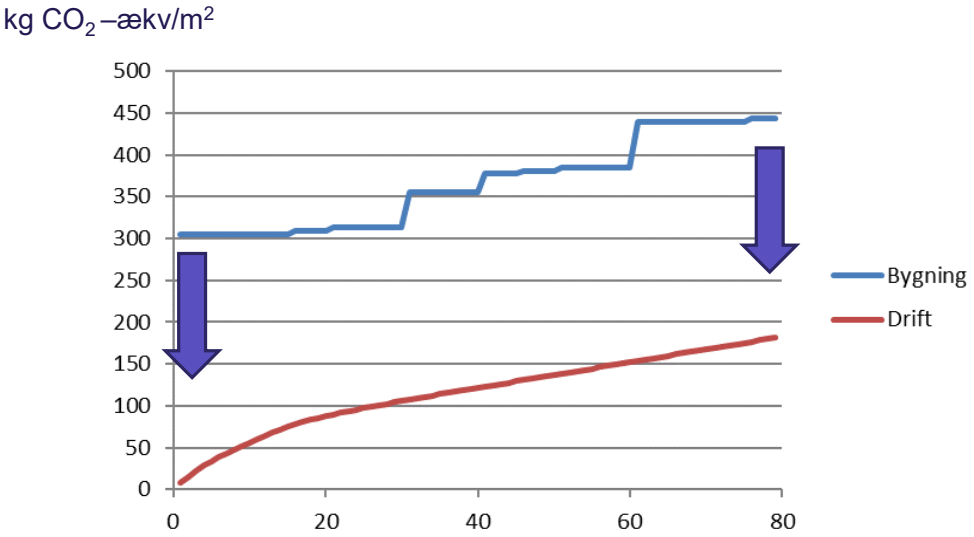
Residential
120 years

Supported by recent Danish cases (SBI 08:2017)



Reuse/Recycling Circular Economy?

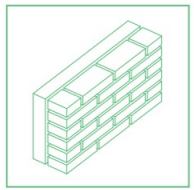
Many circular strategies targeting different solutions and timescales



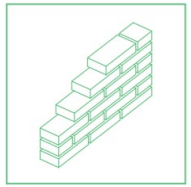
Upcycling

Design for disassembly

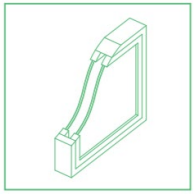
Data needed for all solutions – example:



- Upcycling reused bricks as facade elements
- **61%** CO_2 reduction compared to new bricks



- Reuse old bricks
- **78%** CO_2 reduction compared to new bricks



- Reuse glass from windows in new windows
- **97%** CO_2 reduction compared to new glass in windows

Design strategies for reducing embodied emissions

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  - Natural materials
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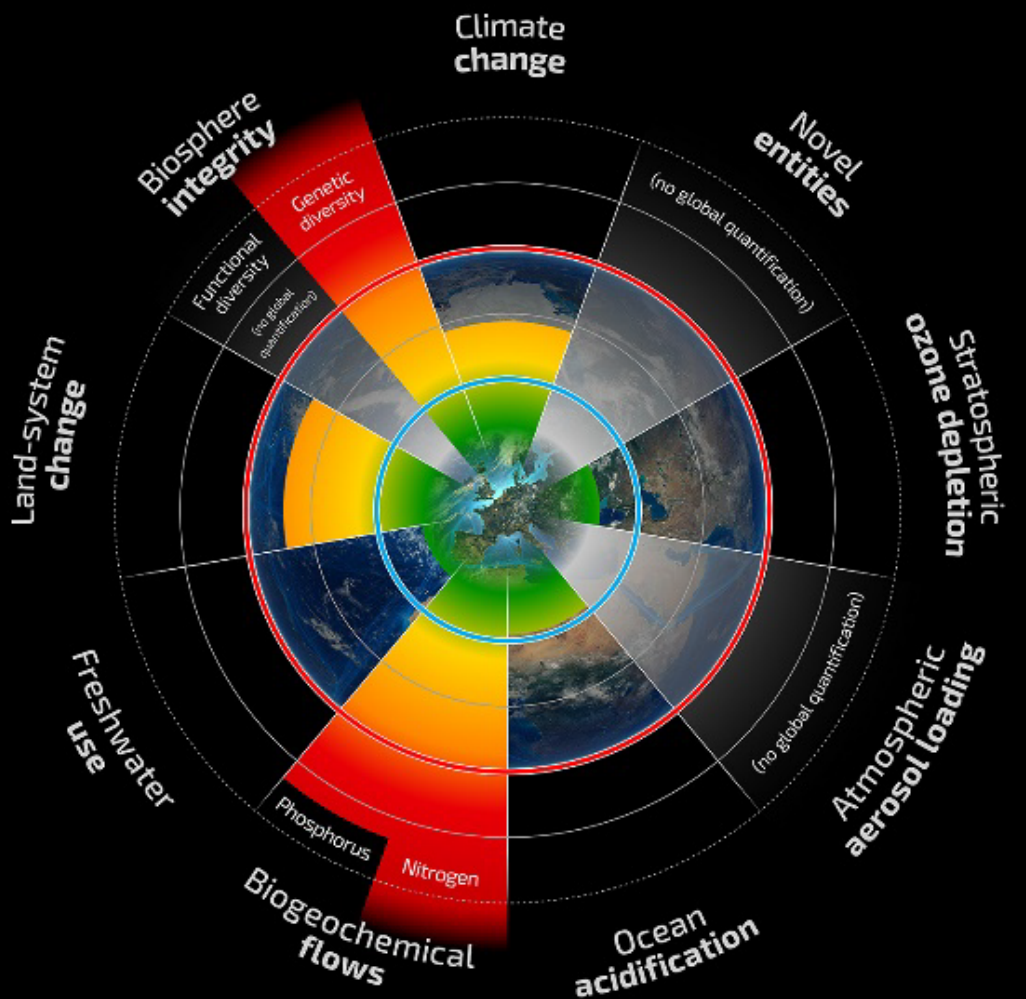
Planetary Boundaries

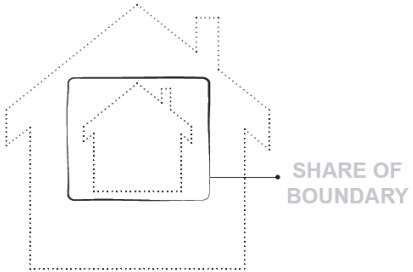
A safe operating space for humanity

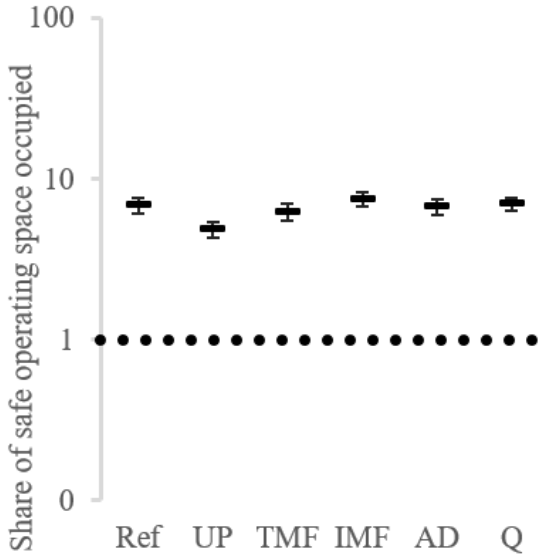


- **Beyond zone of uncertainty** (high risk)
- **In zone of uncertainty** (increasing risk)
- **Below boundary** (safe)
- **Boundary not yet quantified**

Steffen et al. (2015). Planetary boundaries: Guiding human development on a changing planet. *Science*
Grafik: Globaïa

Absolute environmental sustainability – climate change





Assessing building's absolute environmental sustainability performance using LCA

Pernille Ohms[a], Camilla Andersen[a], Freja Nygaard Rasmussen[b], Morten Rydberg[c], Michael Hauschild[c], Morten Birkved[d], Harpa Birgisdottir[b]

We also need to think about the size….

We all need to work together on this task

Fridays for Future, Ljubljana September 27th 2019