The sustainability effects of Product/ Service-System design validated through Life Cycle Assessment

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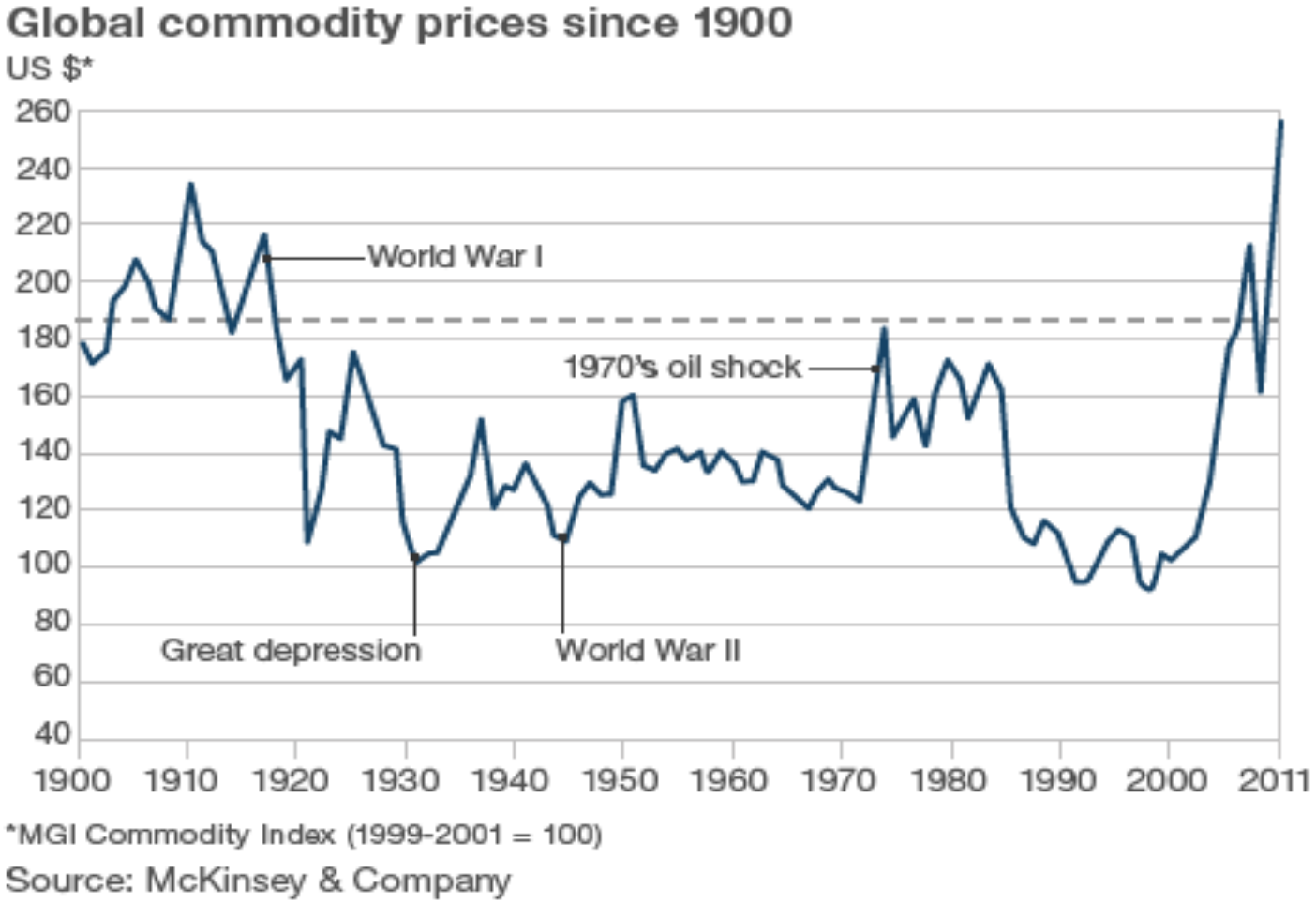
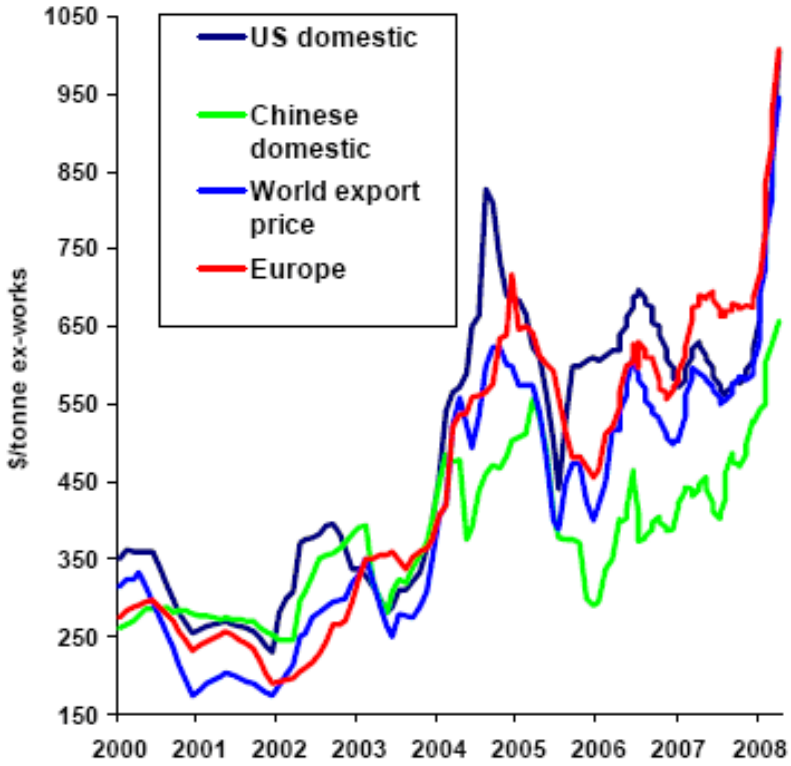
Technical University of Denmark

DTU

Resource depletion and increasing prices



Example: Steel



Source: Steel Benchmarker, Macquarie Research, April 2008

The demand for steel is set to rise by 80% between 2010 and 2030

http://www.bbc.co.uk/news/business-16391040

Waste in EU27 countries

http://www.ecy.wa.gov/programs/swfa/greenbuilding/images/CDLlandfill.jpg

How do we treat our resources?

Business as usual
(in Denmark)

Product/Service-Systems
(abbreviated as PSS)

Case study:
The ‘Eco-box’

Is PSS more environmentally sustainable?

We applied comparative LCA and the following theoretical frameworks to look for an answer.

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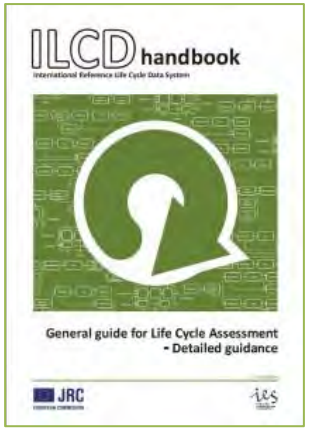


European Committee for Standardization
Comité Européen de Normalisation
Europäisches Komitee für Normung

DGNB®
Deutsche Gesellschaft für Nachhaltiges Bauen e.V.
German Sustainable Building Council

Functional Unit

Providing 790 m² office space in Denmark

for 8 years (2013-2021)

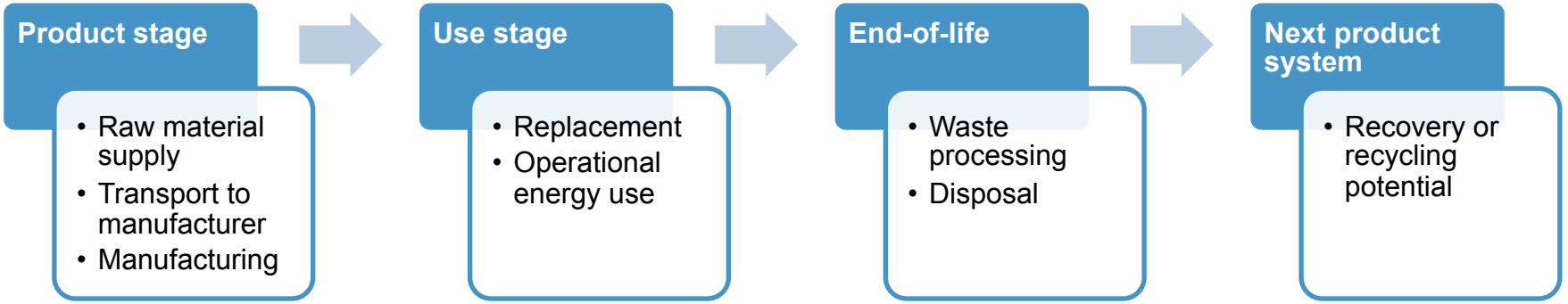
including heating, ventilation and cooling

in accordance with the Danish energy requirements for 2015.

Two scenarios: PSS and conventional

End-of-life treatment	Product/Service-System (PSS)	Conventional (conv)
Prepare for re-use	Containers Steel foundation Scaffolding HVAC elements Lift	None
Recycling	Plastics Gypsum Wood based materials Windows and doors Fibre cement Staircases and bridges Screws, bolts and nails	Containers Steel foundation Scaffolding Windows and doors Staircases and bridges HVAC elements Wood based materials Plastics Gypsum Screws, bolts and nails Lift
Recovery (energy recovery rate >60%)	Bitumen Cellulose insulation UPM flooring Roof cover	Bitumen Cellulose insulation UPM flooring Roof cover

Life cycle stages included in the study



Defined in accordance with DGNB

LCIA methodology

ReCiPe 2008 v. 1.08 (Hierarchist)

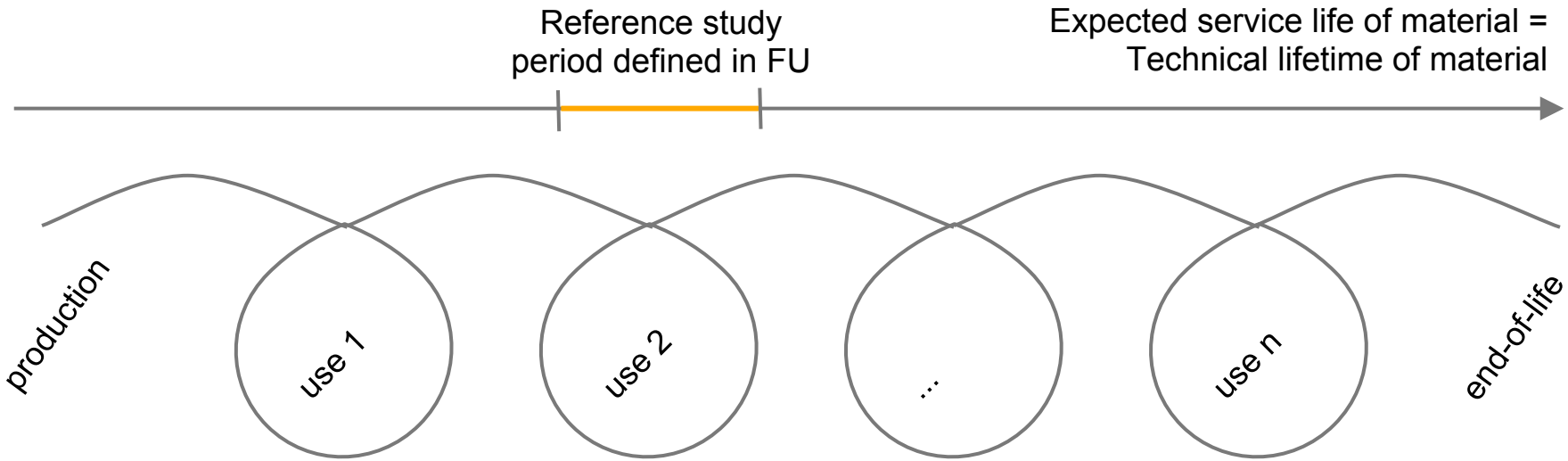
LCA modelling framework for recycling

System expansion

In accordance with the ILCD handbook (Situation A),
ISO 14044:2006 and EN15978:2011 (CENTC/350).

LCA modelling framework for re-use

1. Calculate total LCI of the material (cradle to grave)
2. Allocation key for re-used material * = $\frac{\text{Reference study period defined in FU}}{\text{Expected service life of material}}$

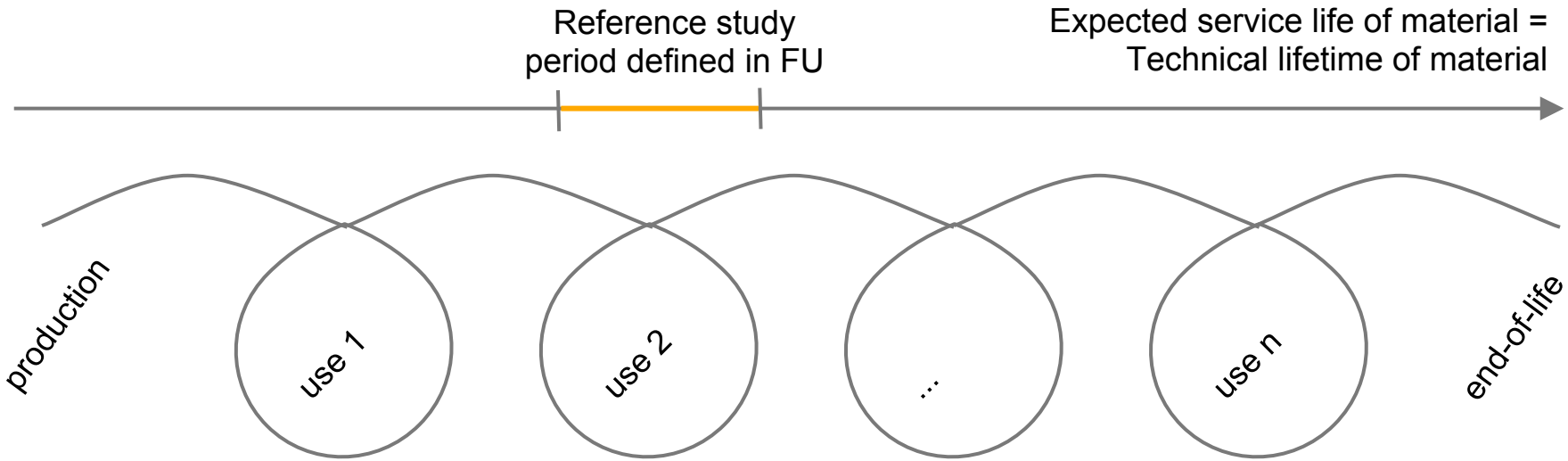


* Based on the assumption that the value of use is constant throughout the technical lifetime of the material.

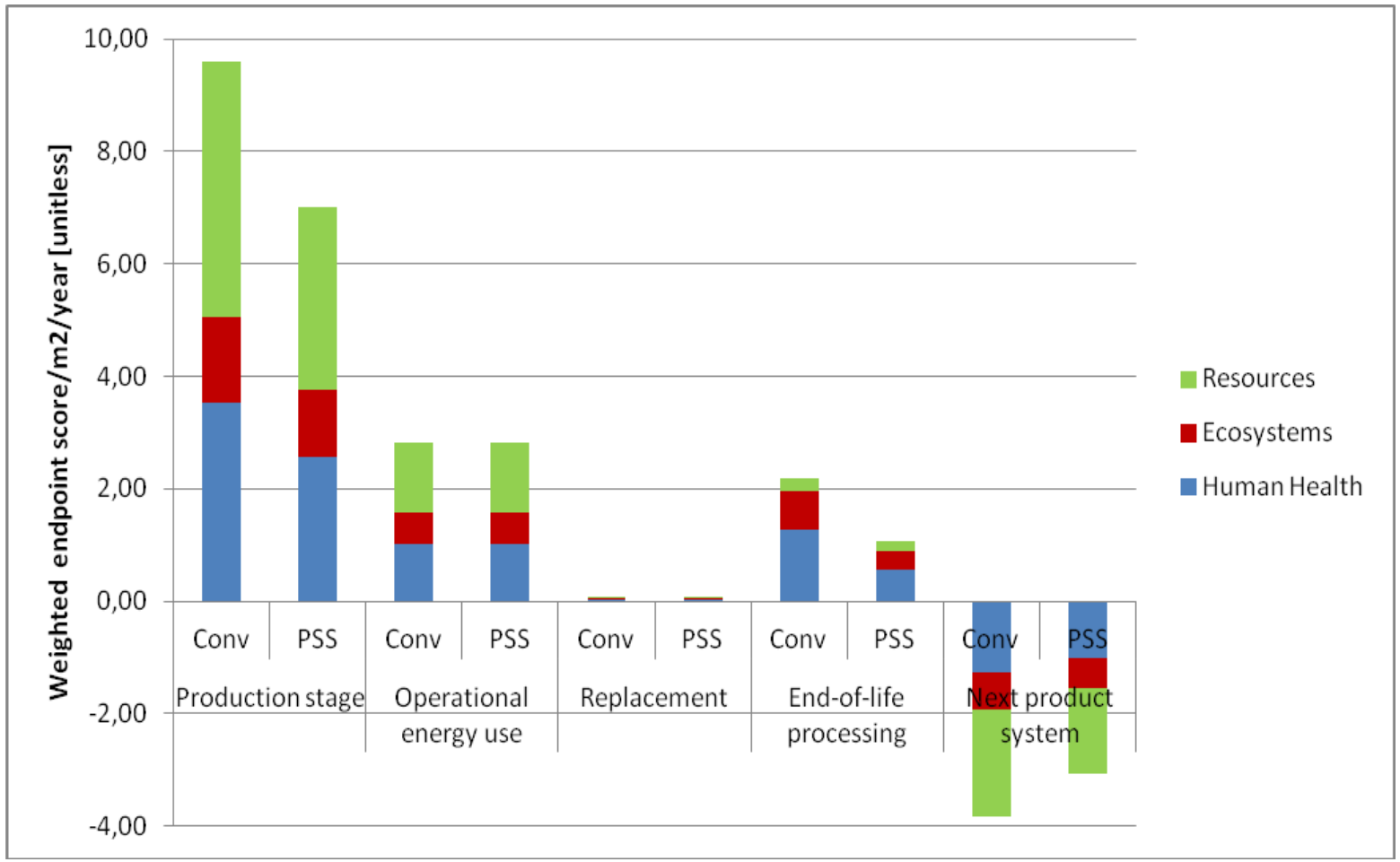
Modelling framework – re-use

Example:

$$\text{Allocation key for re-used container} = \frac{\text{Reference study period defined in FU}}{\text{Expected service life of container}} = \frac{8 \text{ years}}{25 \text{ years}} = 0.32$$



Results (ReCiPe Hierarchist)



Results

The PSS scenario has a lower impact in all midpoint categories than the non-PSS scenario over the whole life cycle.

In terms of aggregated endpoint score (ReCiPe H):

- The environmental impact score of individual materials can be reduced with up to 85% by reuse through a PSS
- The PSS approach led to a 27% reduction in the product stage.
- The end-of-life processing is reduced by 52% in the PSS solution, due to avoided energy-heavy recycling of metals.

Conclusions

Reusing building materials is more environmentally sustainable than recycling and incineration

Borrowing rather than **buying** building materials for temporary buildings can ensure that the building materials are treated in the best possible way

Borrowing and reuse is made possible through **circular business models** such as **Product/Service-Systems**

Danke

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