Zero Emissions Buildings
How is wood part of the solution?

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Forum Holzbau Nordic, 24-26 September 2014
Rica Nidelven Hotel Trondheim

ZEB The Research Centre on Zero Emission Buildings

FME CENTRE FOR ENVIRONMENT-FRIENDLY ENERGY RESEARCH

Research Centre on Zero Emission Buildings

The main objective is to develop competitive products and solutions for existing and new buildings that will lead to market penetration of buildings with zero greenhouse gas emissions related to their production, operation, and demolition. The centre will encompass both residential, commercial, and public buildings.

www.zeb.no

Multicomfort Larvik ZEB Demo house
Illustration: Snøhetta/EVE

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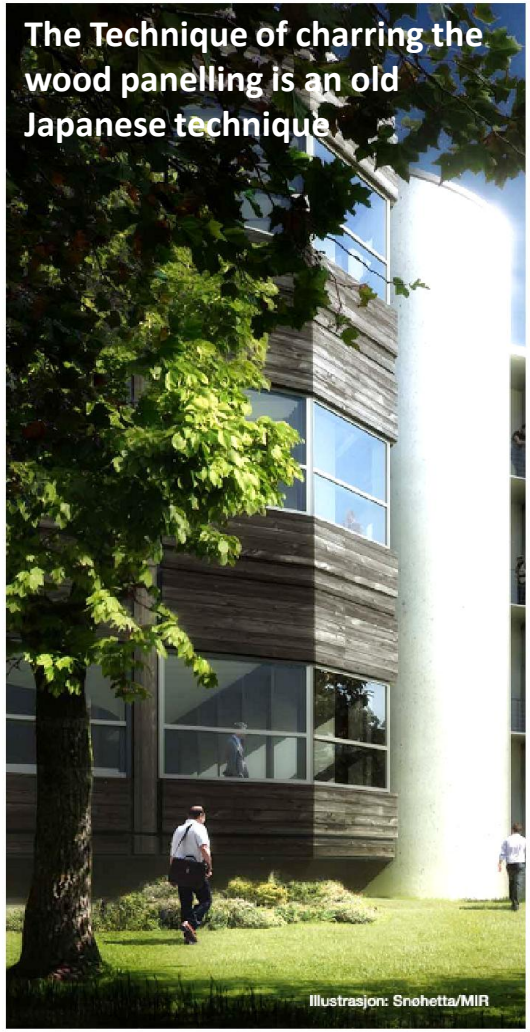
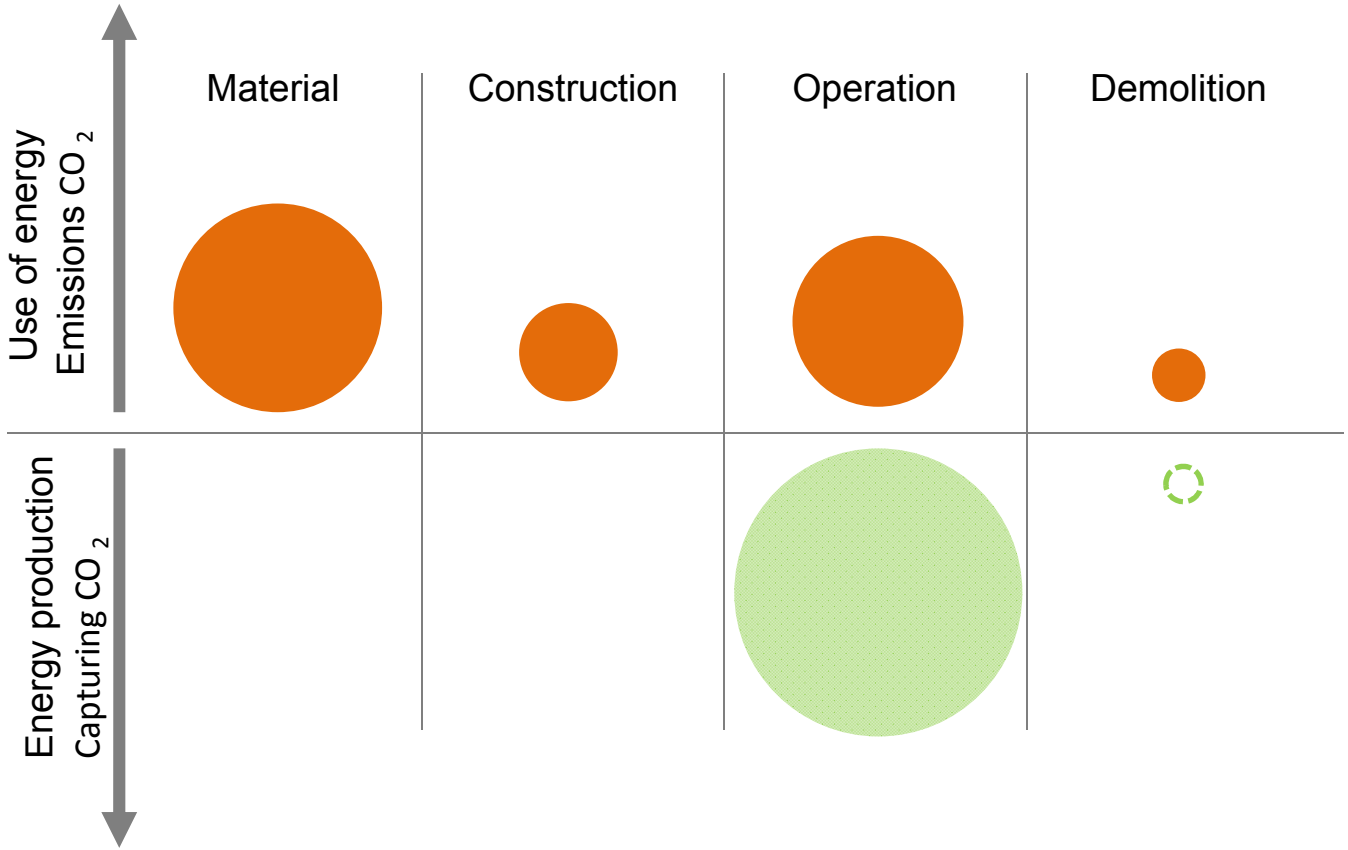
CENTRE FOR ENVIRONMENT-FRIENDLY ENERGY RESEARCH

Use of Wood in ZEB Pilot Projects

Powerhouse Kjørbo

Powerhouse Kjørbo
New facade in burned wood





Adapted from Risholt et al. 2014

Background - ZEB Office Study

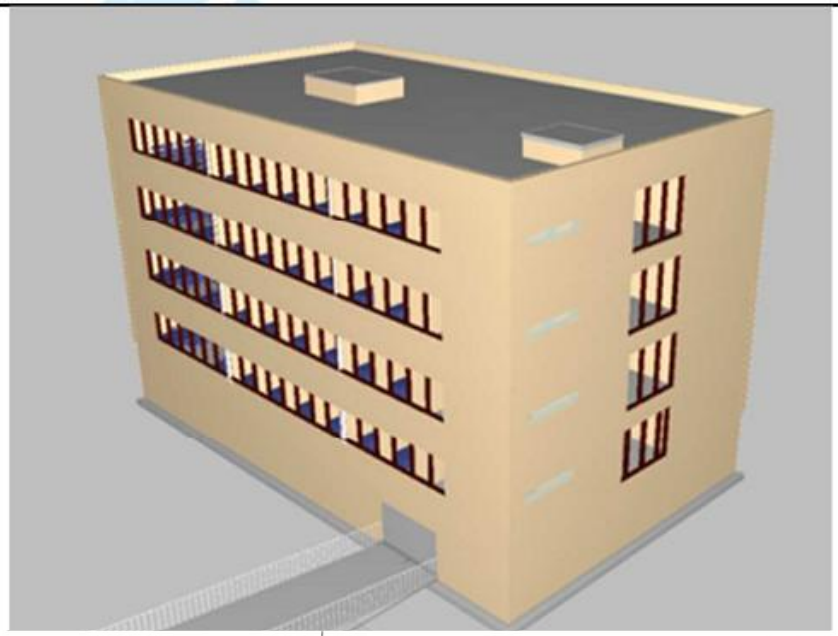
- Goal to gain insight into the current challenges and status for achieving a Zero Emission Office Building in Norway

- Use of a virtual model to test out different approaches and methods

Reference: Dokka, T. H., Kristjansdottir, T., Mellegård, S., et al. (2013b). *A zero emission concept analysis of an office building* . The Research Centre on Zero Emission Buildings (ZEB) (Ed.) Retrieved from http://www.sintefbok.no/

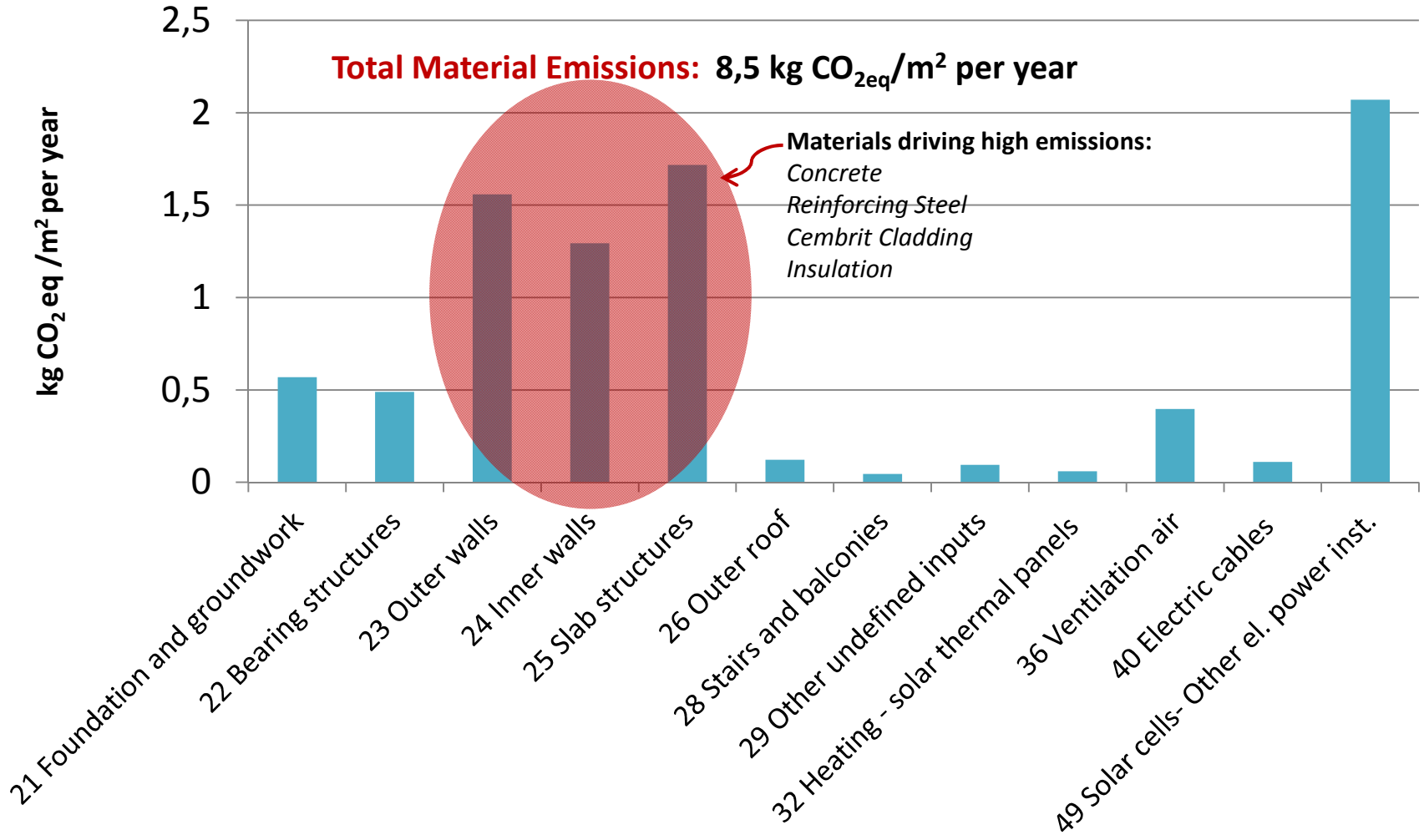
Main characteristics of the ZEB Office model

Number of floors [-]	4
Heated floor area [m²]	1980
Window area [m²]	456
Number of workspaces	113
Annual energy demand [kWh/m².year]	
Heating	22.6
Cooling	6.4
Electric	27.7
CO_{2eq} emissions [$kgCO_{2eq}/m^2$.year]*	
Total electricity use	4.4
Embodied emissions	8.5
PV production	6.9

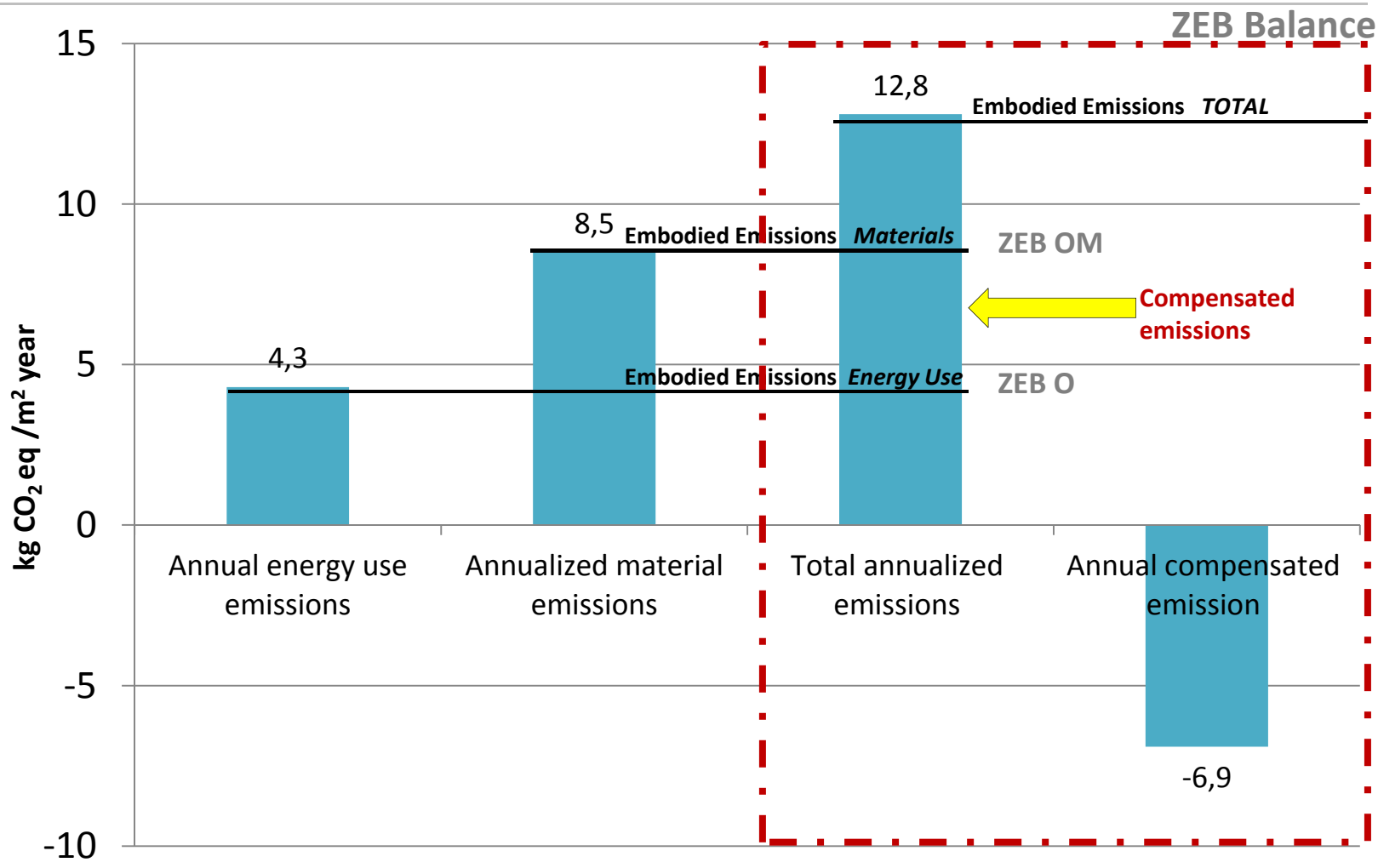


**Computed according to the baseline scenario*

Embodied Emissions – total and distribution



Results combined – from first phase



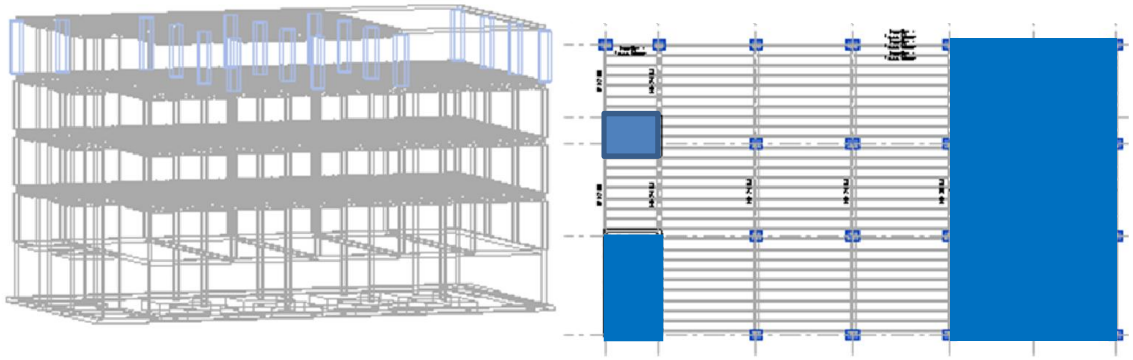
Results and Questions

- Material emissions (67%) are higher then operational emissions (33%) over the estimated service lifetime of 60 years.
- Renewable energy offsets around 50 % of the total emissions
- ZEB-ambition level ZEB-O is achieved but ZEB-OM is not achieved with the current approach

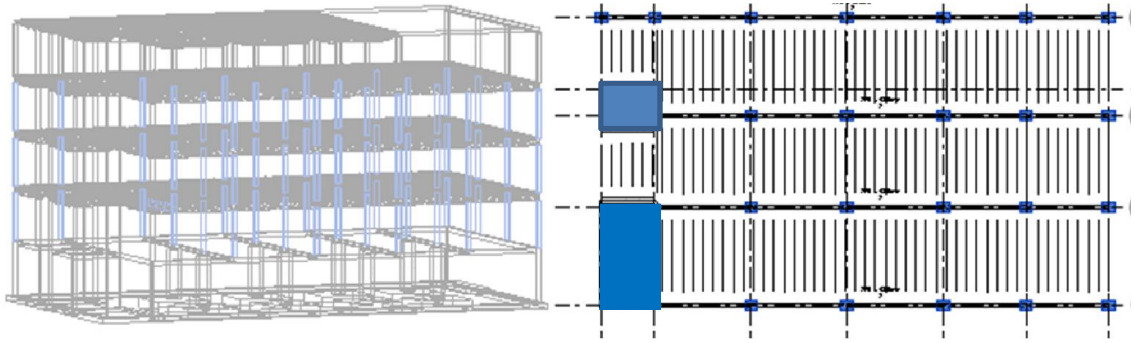
- Which are the key materials driving high emissions?
- What are the alternatives?
- How do we reduce the quantities (thus emissions) of these materials?

Structural Changes

4 Floor



1-3 Floors



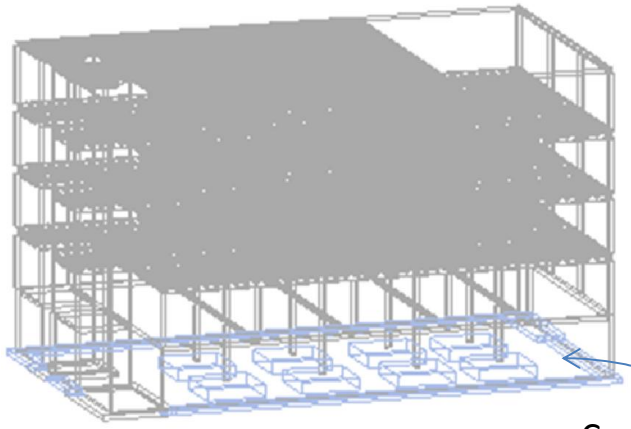
Timber

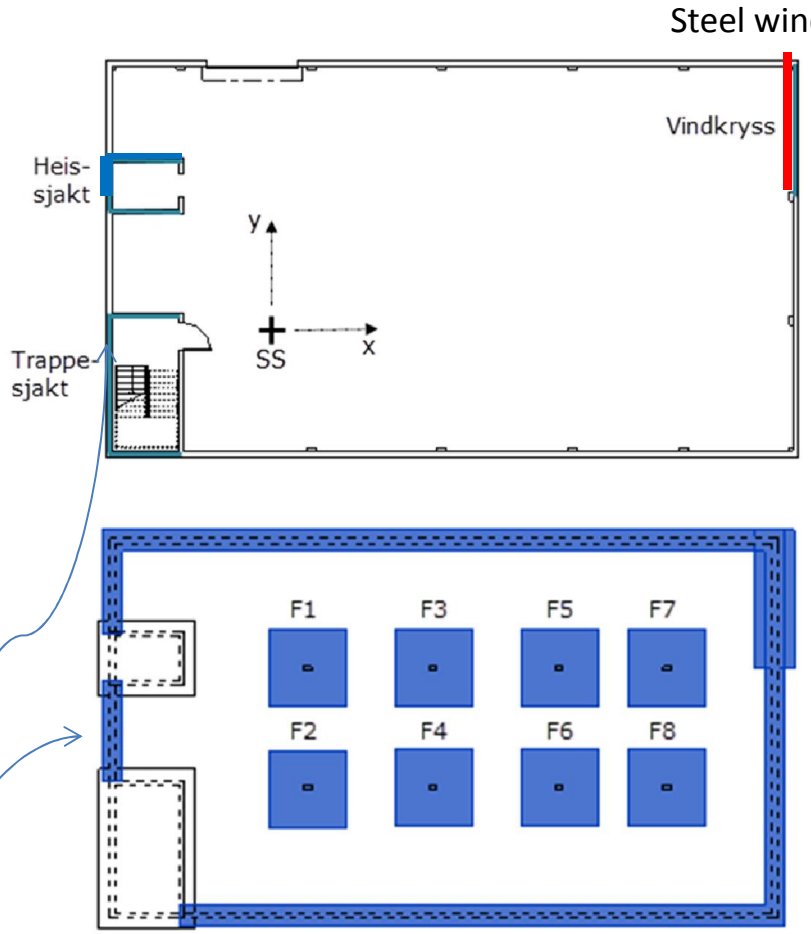
Concrete

Structural Changes

The new **wood structure** is lighter than the original concrete & steel thus reducing the load on the foundations and basement, resulting in:

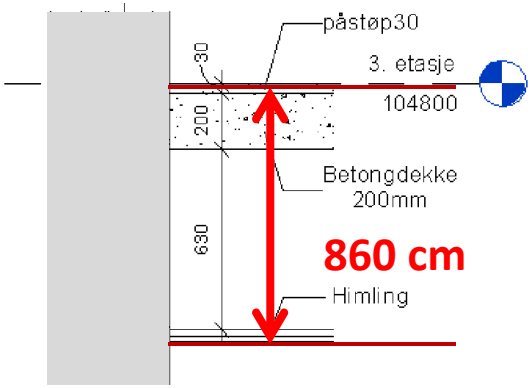
- **50% reduction** in **amount (m^3)** and **emissions ($kgCO_{2eq}$)** in concrete & reinforcing steel being used

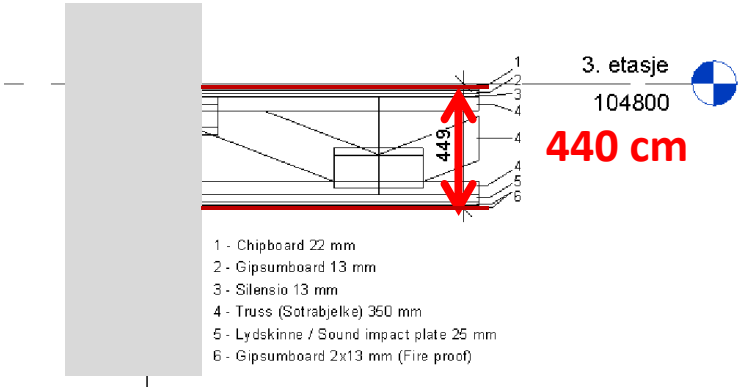




Concrete in basement walls, foundation & lift, stair shafts

Structural Changes





ZEB Office (original)

Load bearing structure

Concrete and steel

ZEB Wood

Load bearing structure

Glue laminated timber

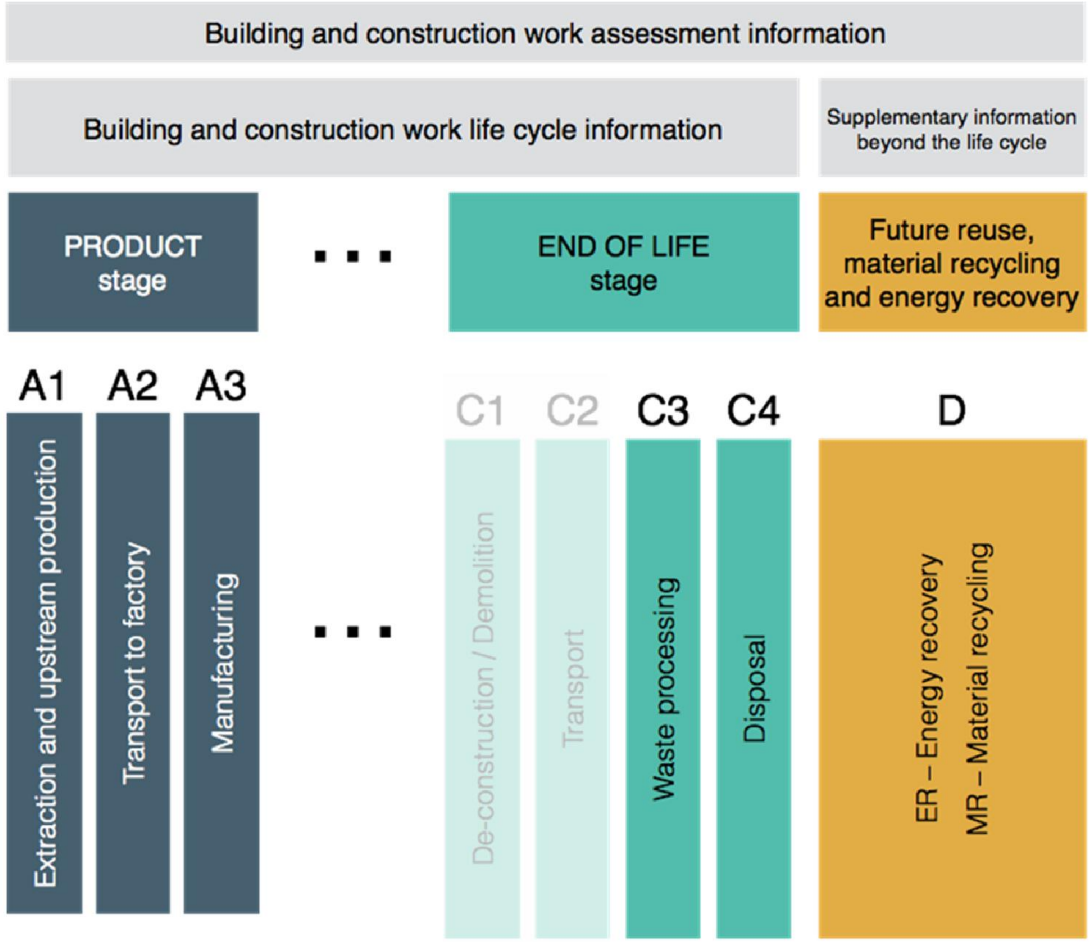
Objective

Extend life cycle boundary

Gain understanding of end-of-life treatment alternatives

REASON: positive and negative wood emission accounting balances out considering the whole life cycle

Cradle to gate with end-of-life option



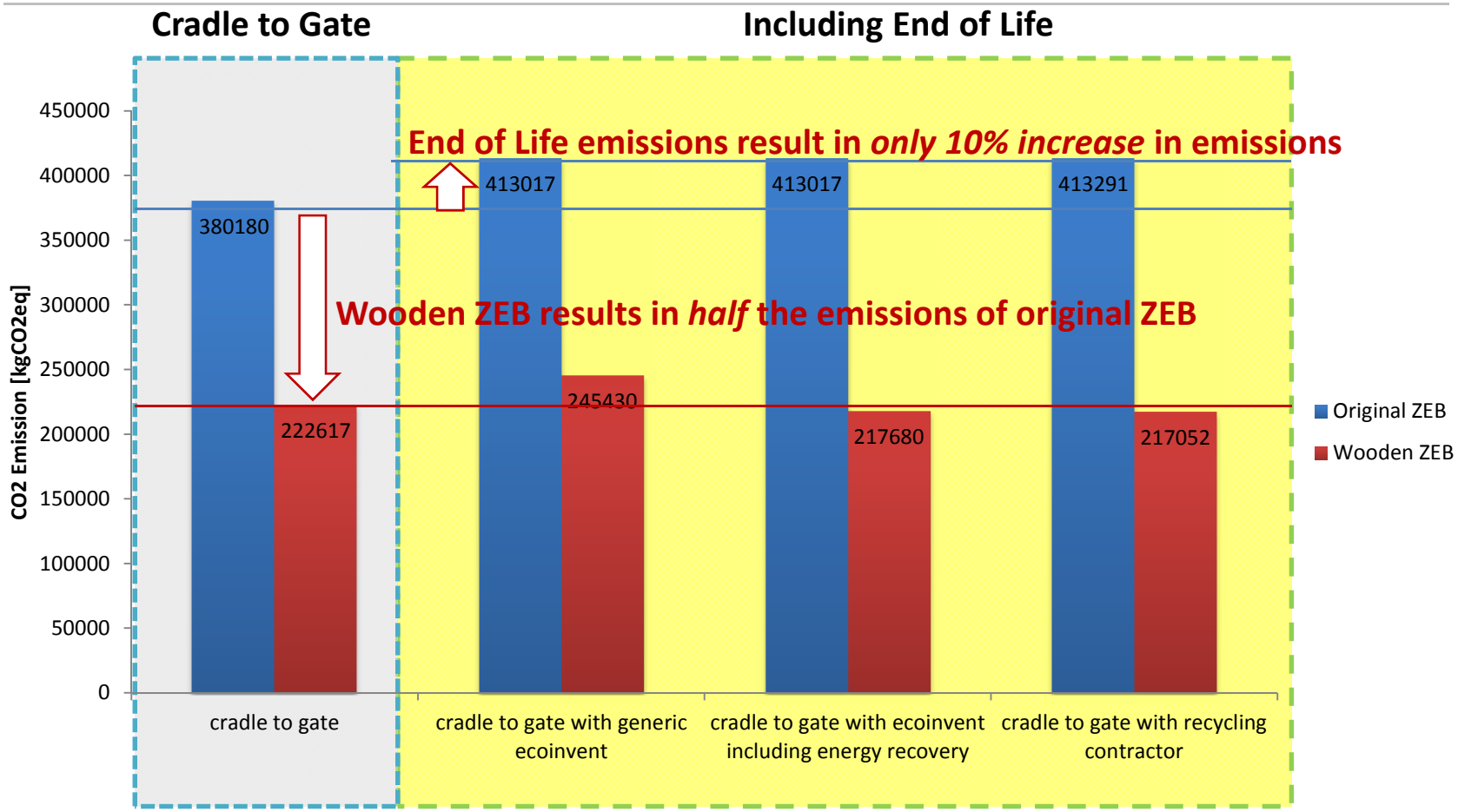
End of Life Scenario's

- **Generic EcoInvent:**
- follows the recommended end-of-life treatment for building materials
- no energy recovery from waste materials treated with the process of municipal incineration

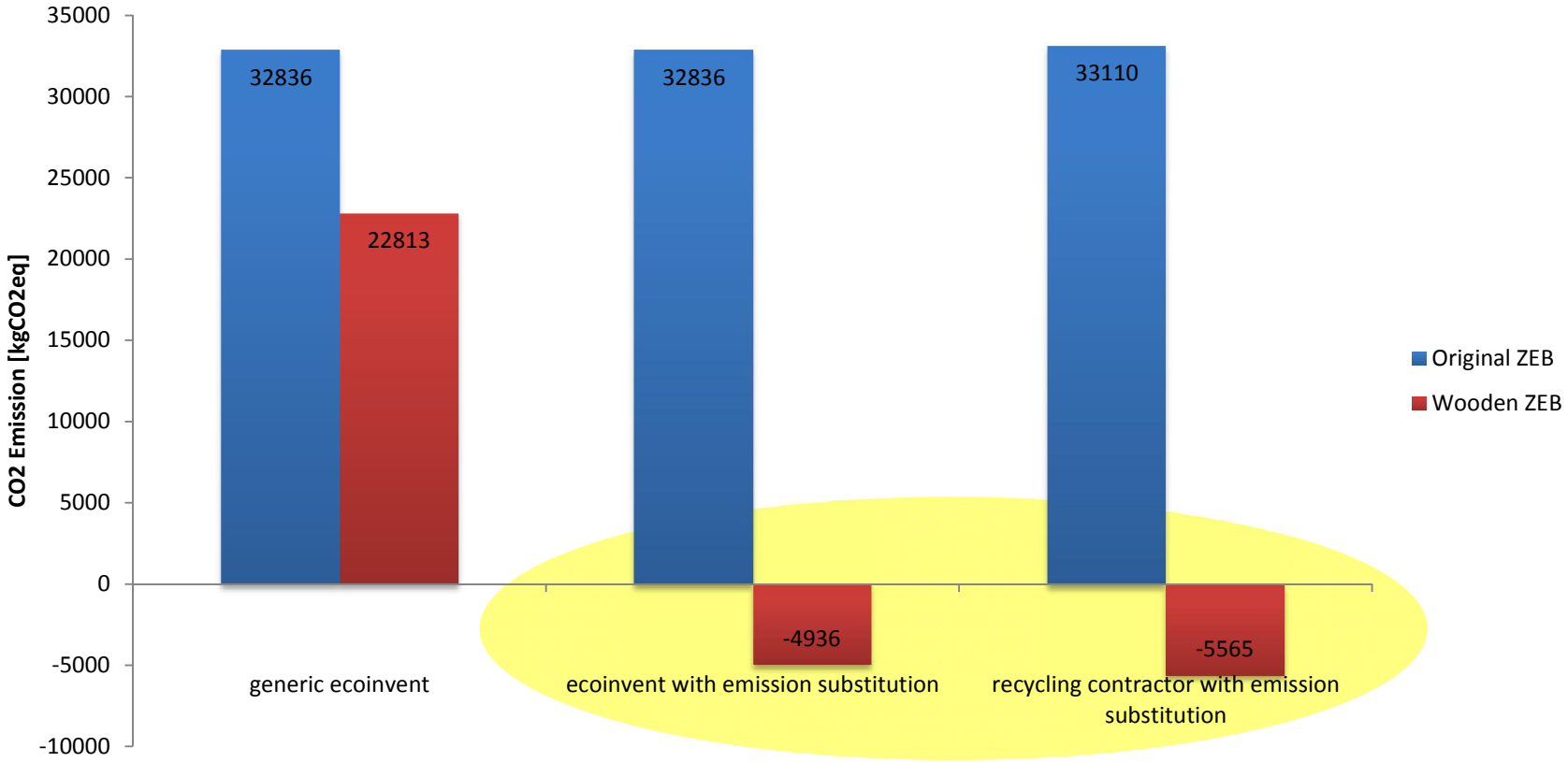
- **EcoInvent with Energy Recovery:**
- Consideration of energy recovery from municipal incineration
- Emissions savings are factored in when recovered energy substitutes fossil fuel

- **Norwegian Recycling Contractor:**
- Processing data provided by Norwegian recycling contractor which were modeled with SimaPro in order to attain emission data
- Emissions savings are factored in when recovered energy substitutes fossil fuel

Results ‘cradle-to-gate’ with ‘end-of-life’

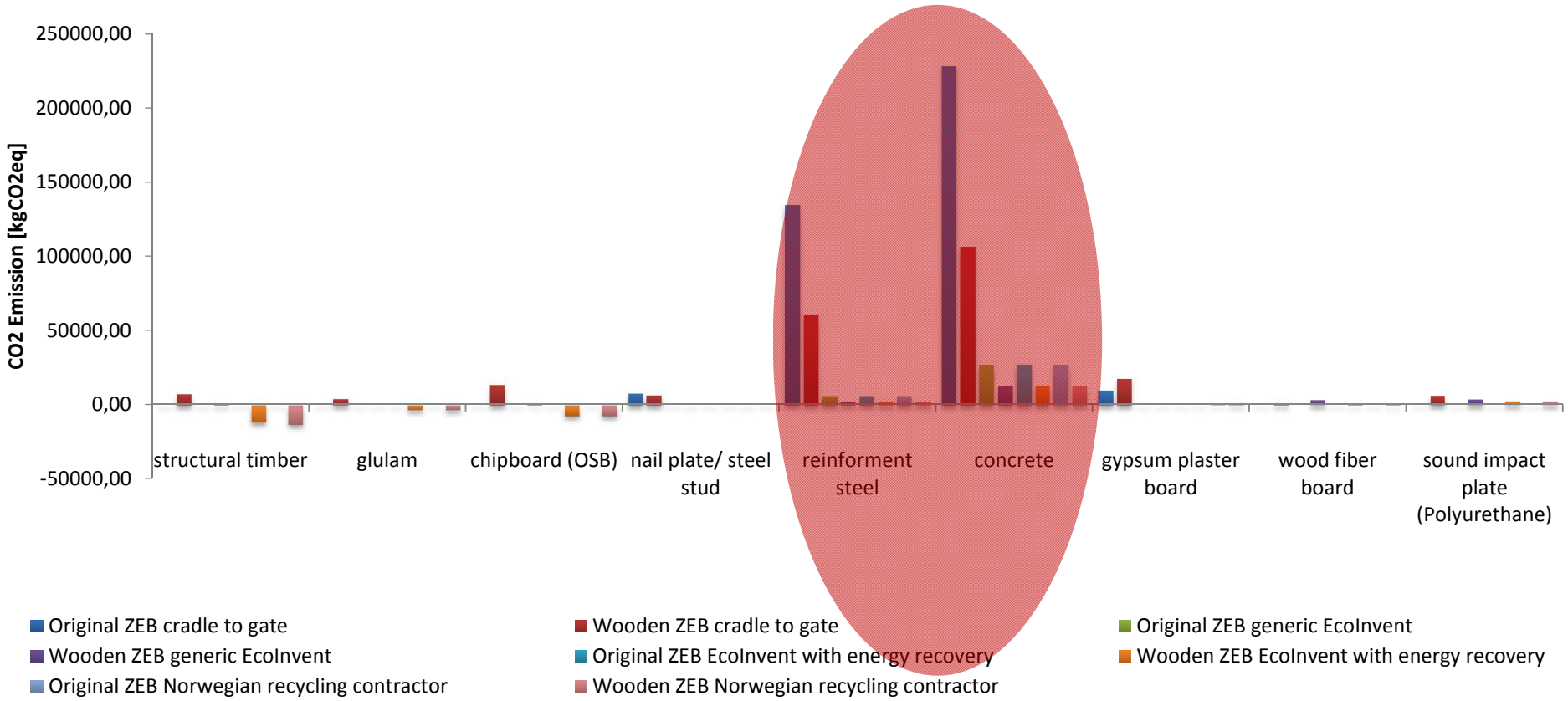


Results with energy recovery (only ‘end-of-life’)



Energy recovery from wood allows for significant emission savings due to fossil fuel substitution
If wood is incinerated, emissions for steel and concrete recycling are counterbalanced.

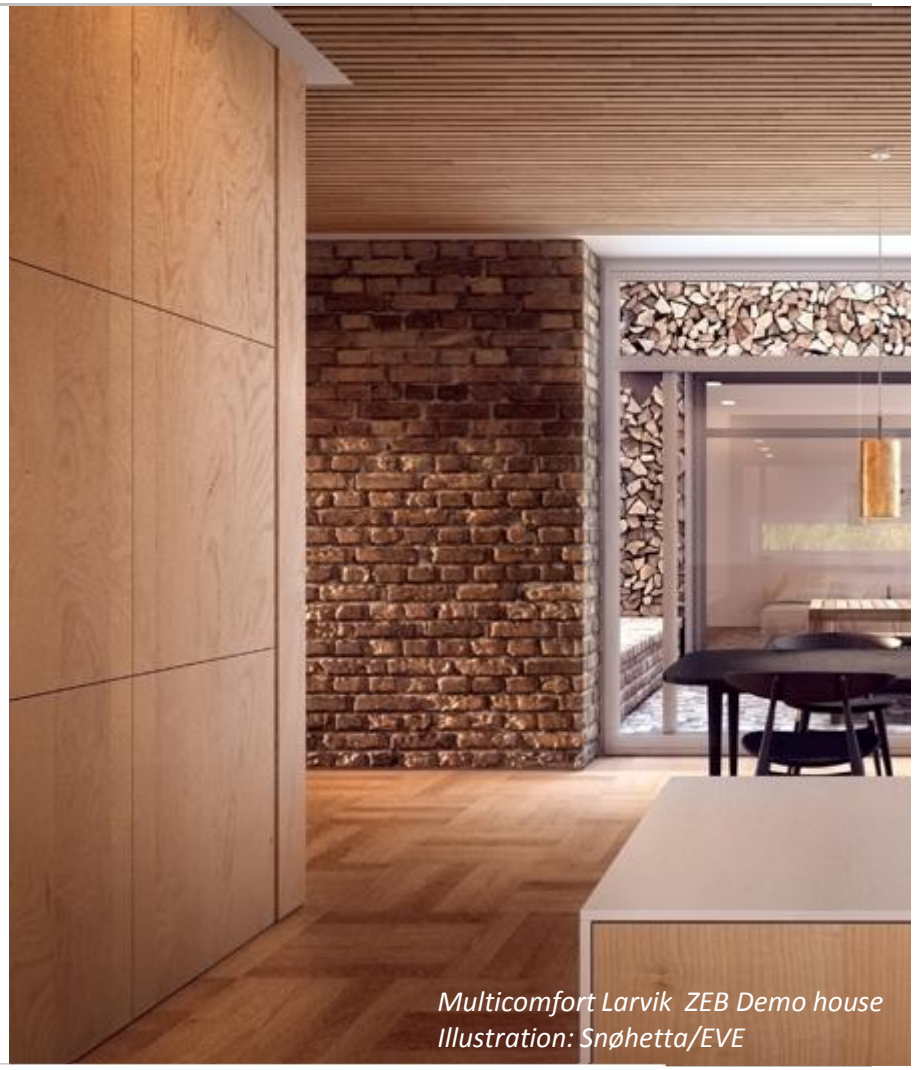
Results per material



Further Steps

'Norwegianise' the model and assess impact on emissions

- Replace generic data with specific EPD data for those materials produced in Norway e.g. wood, concrete, steel and insulation materials.
- Extend system boundaries to include emissions from the transport of materials from cradle to building site.



Multicomfort Larvik ZEB Demo house
Illustration: Snøhetta/EVE

ZEB – How is wood part of the solution?

- End-of-life emissions contribute to only 10% overall emissions
- Lighter wooden structure leads to:
  - 30% reduction in material quantities used
  - 50% reduction in concrete and reinforcing steel used and associated emissions
- During End Of Life (EOL):
  - Energy recovery from wood allows for significant emission savings due it substituting fossil fuel
  - Wood can be treated in two ways:
    1) Incinerated to generate heat in a district heating plant
    2) Reused /recycled

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