Decreasing the carbon footprint of energy efficient buildings, what comes next?

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INTRODUCTION

The construction sector is responsible for around 33% of society's greenhouse gas emissions. There has been a focus on increasing energy efficiency in buildings and eco-efficiency in the energy supply, as previous studies have pointed to the use stage of the building as the most environmentally and energy intensive. This focus has led to substantial reductions of the carbon footprint of buildings, but mainly in the use phase.

OBJECTIVE

The purpose of the work described is to explore in a practical case study the contribution from other life cycle stages to the carbon footprint from energy efficient buildings, and the role of bio-based materials as future potential alternatives to decrease carbon emissions in the building sector.

METHODOLOGY

LCA was used to analyze the potential environmental impact from different design alternatives with comparable functionality for Wälluden, a four-storey multi-family building constructed in 1996 in Växjö, Sweden. There are sixteen apartments in the building, with a total of 1190m^2 of heated area and 928 m^2 of living area.

A cradle-to-grave LCA was performed for eight different design alternatives: Volumetric modules, CLT and beam-column systems both for conventional and passive house designs plus original designs in wood and concrete. A square meter of living area was assumed as the functional unit.

Data for production (A1-A3) is from SPs inventoried database, EPDs, literature and existing databases. Data for construction activities (A4) is from literature. Data for use phase energy (B6) is from the local energy supplier. Data for end-of-life processes (C1-C4) is from Ecoinvent.

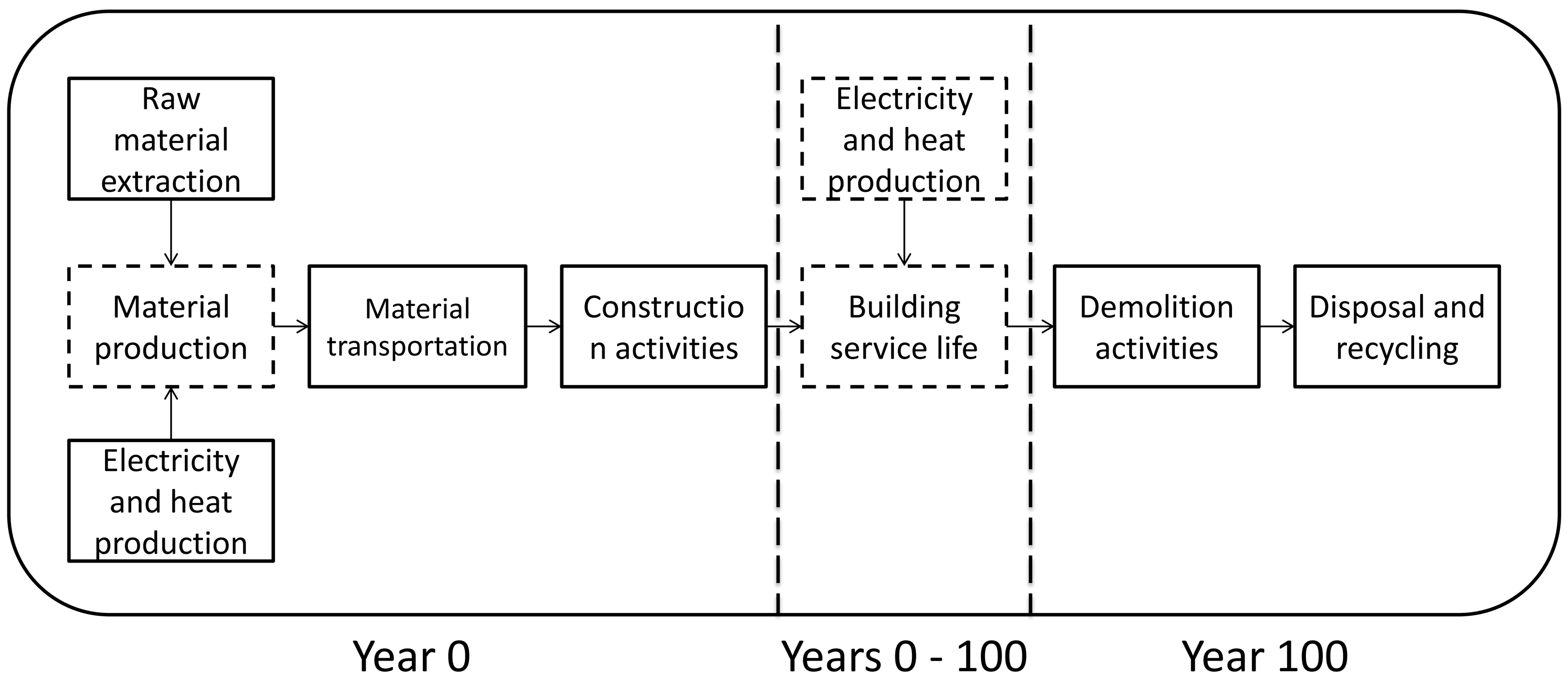


Figure 1 (above) shows the system boundaries for the study

SENSITIVITY ANALYSIS

The sensitivity of the results to the choice of the data for the heat supply in the use phase was analyzed. For this, a Swedish average mix for heat production was used instead of site-specific data for Växjö, in order to explore the impact of background energy systems in the results.

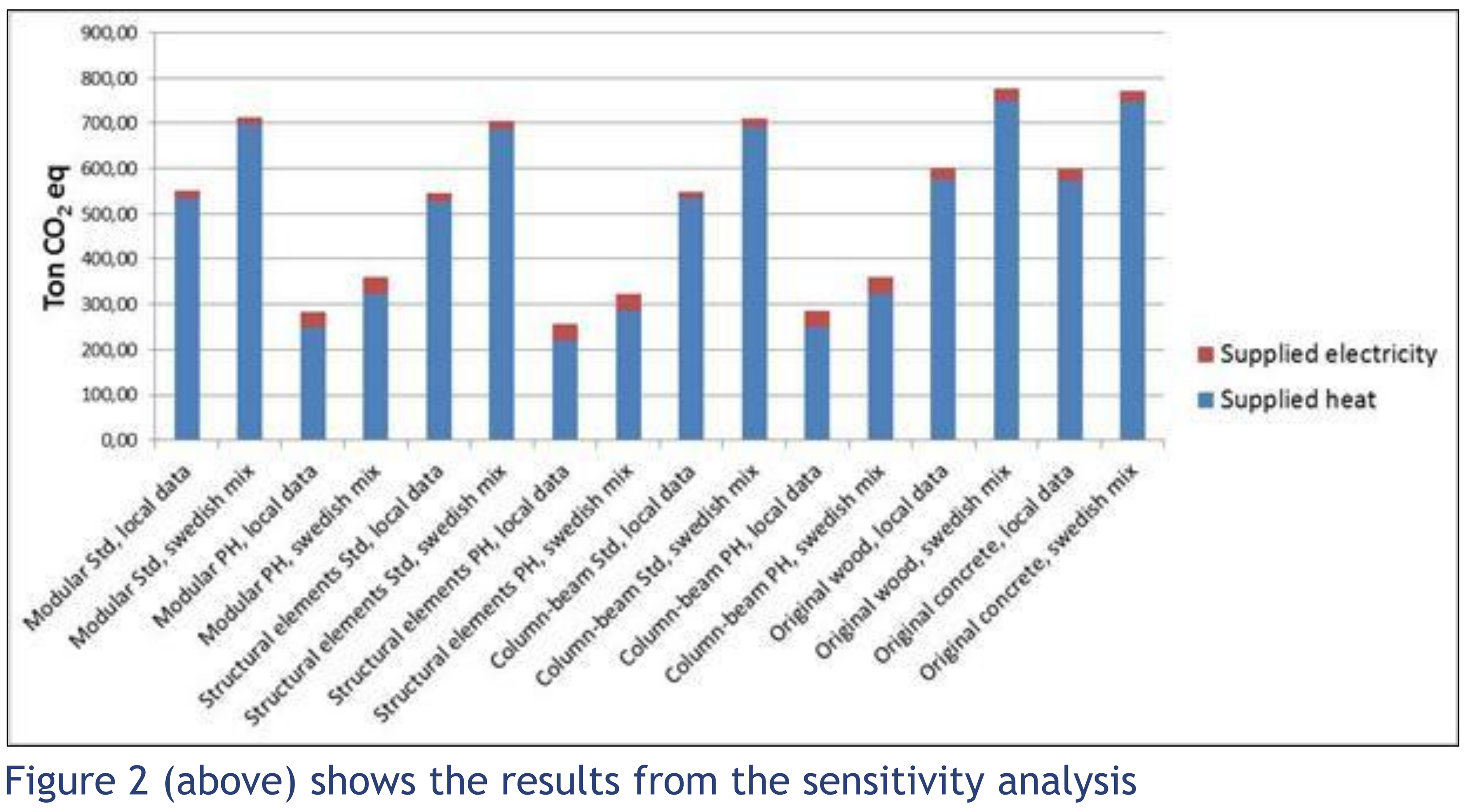


Figure 2 (above) shows the results from the sensitivity analysis

RESULTS

Figure three (below) shows the carbon footprint for the production phase only. The contribution from wood materials can be compared with other types.

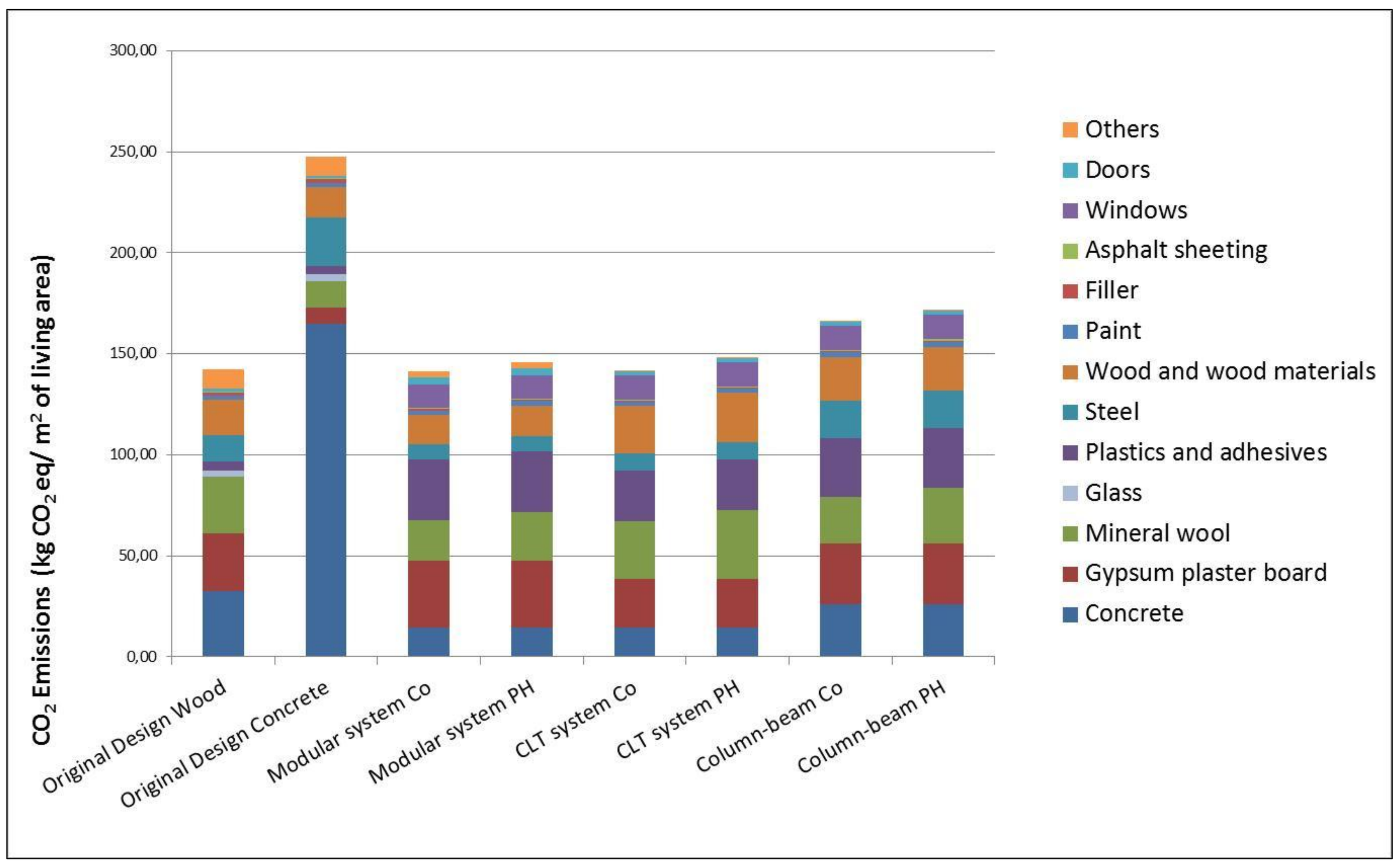
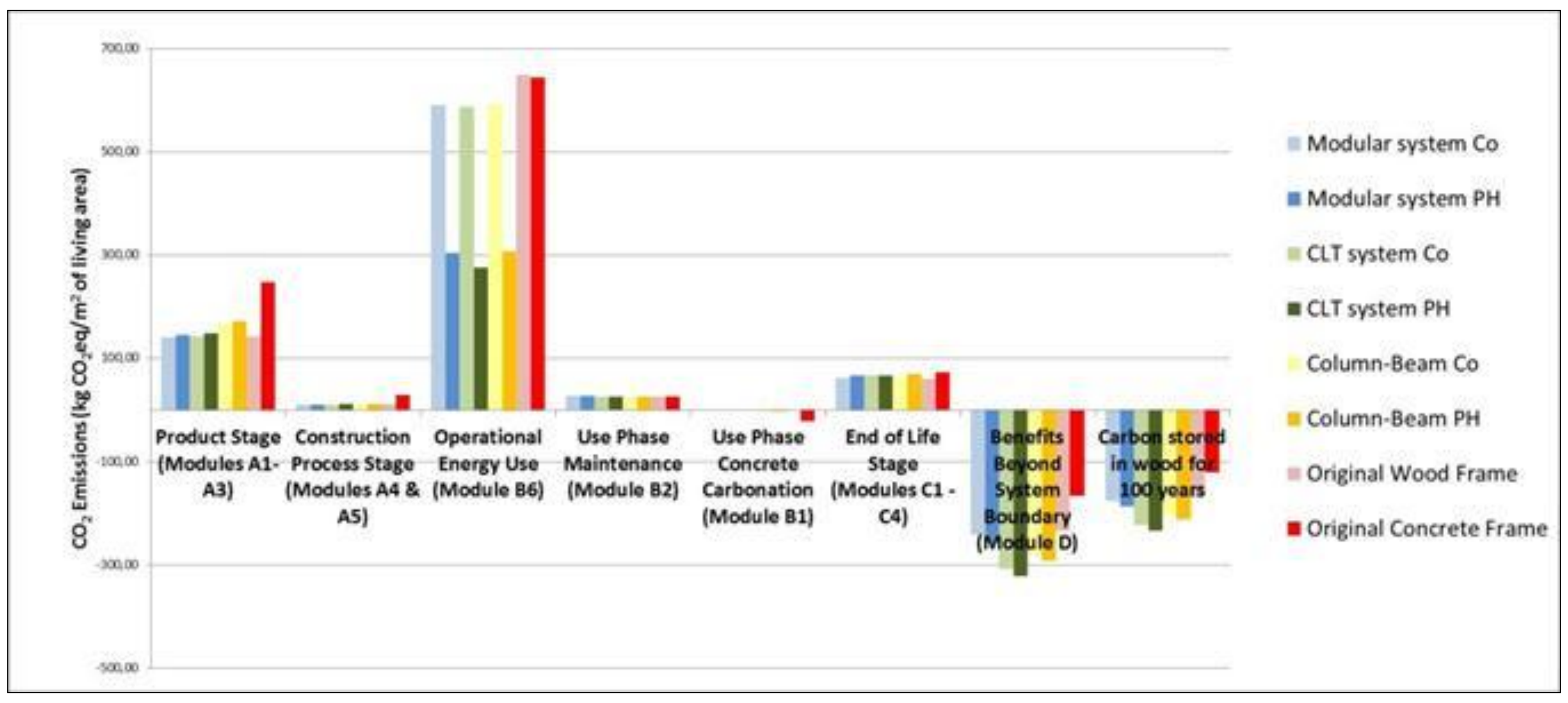


Figure four (below) shows the life cycle carbon footprint for 50 years service life. The results are presented in modules as in EN 15804.



CONCLUSIONS

For more energy efficient building designs or buildings supplied from energy systems with lower carbon footprint, the production and end of life stages are highly relevant.

The use of wood and bio-based materials can significantly decrease further the carbon footprint of energy-efficient buildings. This potential can be seen in the production stage, the construction activities, the end-of-life stage and the potential environmental benefits beyond the end-of-life.

The operational stage results dominate the carbon footprint due to the operational energy supply. The use of wood materials in the design and the choice of building system do not influence this outcome as much as the energy efficiency standard followed and the energy supply system modeled in the use phase.

The additional emissions in the production phase caused from the shift from the standard to the passive house design are low, compared with the reduction of the emissions in the operational stage.

Mineral-based and fossil-based materials contribute more to the carbon footprint of the production phase than wood and bio-based materials even in the wood structure buildings. Materials such as gypsum board, concrete and mineral wool present higher contributions to the carbon footprint of the production phase for every design; which means they present the highest potential for lowering further the carbon emissions from production, either by substitution or process optimization.

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