Accelerating low carbon building together

RESULTS ON LOW CARBON BUILDING PROJECT

NCC

stordenso

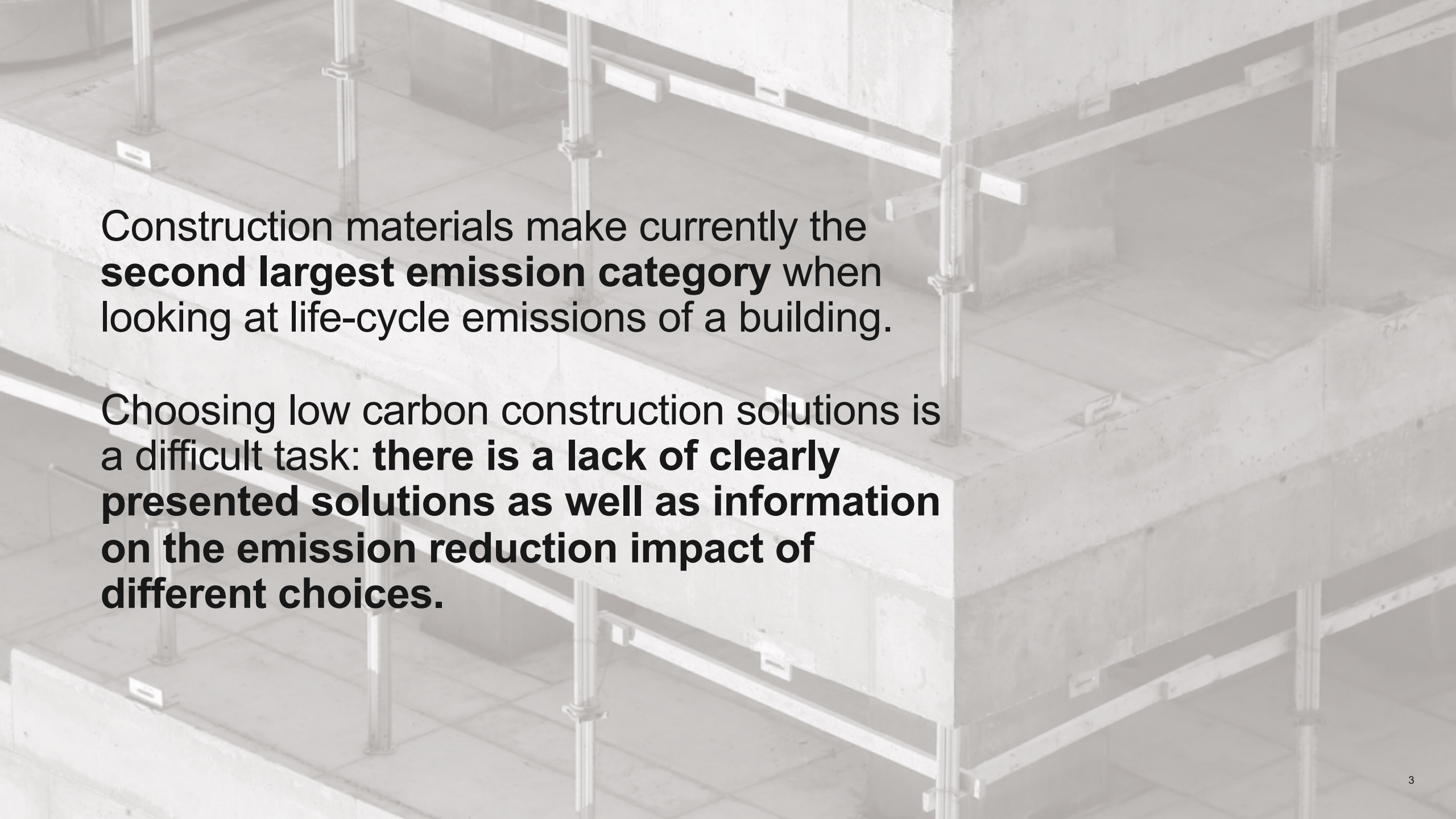
RAMBØLL

Combient Pure

The construction sector is responsible for almost 40 % of annual energy-related greenhouse gas emissions globally.

1,5

CUTTING THESE EMISSIONS IS A MUST TO REACH THE 1.5 DEGREE WARMING PATH



Construction materials make currently the **second largest emission category** when looking at life-cycle emissions of a building.

Choosing low carbon construction solutions is a difficult task: **there is a lack of clearly presented solutions as well as information on the emission reduction impact of different choices.**

NCC Finland, Stora Enso, Ramboll and Combient Pure have joined their forces to help property developers and investors make data-based low carbon construction material choices and take down the industry's emissions.

MULTI-COMPANY COLLABORATION

The multi-company collaboration, led by Combient Pure a neutral orchestrator, focused on six different themes:

1. Studying together with NCC and Stora Enso low-carbon construction materials based on actual designs of a residential and office buildings
2. Charting the needs of property owners and investors through direct interviews and internal workshops between NCC and Stora Enso
3. Developing company-specific internal processes for promoting low-carbon construction
4. Extending the collaboration to a design firm and developing new designs for reference buildings - Ramboll joined the collaboration
5. Studying the emission reduction potential of massive wood based on the designs used and prepared in steps 1 and 4
6. Finalizing joint low carbon solutions and gathering the key findings, preparing communications and discussing their business implications

1 Low Carbon Building Solutions

2 Emission Reduction Potential of Massive Wood

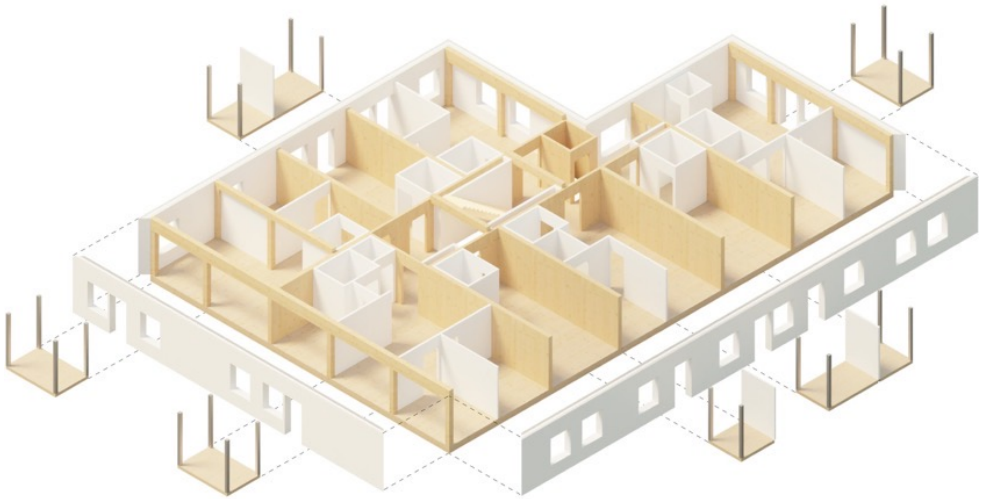
3 Value Chain Collaboration

1. Low Carbon Building Solutions

Multi-company collaboration enables new low carbon building frame designs

- The collaboration enabled the co-creation and examination of different solutions for low carbon buildings, especially by studying **different wood-based structural systems** and construction methods.
- The target was also to increase the level of **industrialization to a maximum**, considering current practices and limitations.
- The building-type specific case studies were conducted for **the office** and **residential building types**.

Residential case study



The aim was to study material-related low carbon possibilities and solutions by reproducing a typical concrete residential project with a massive wood frame.

Two approaches were considered in the residential building case study:

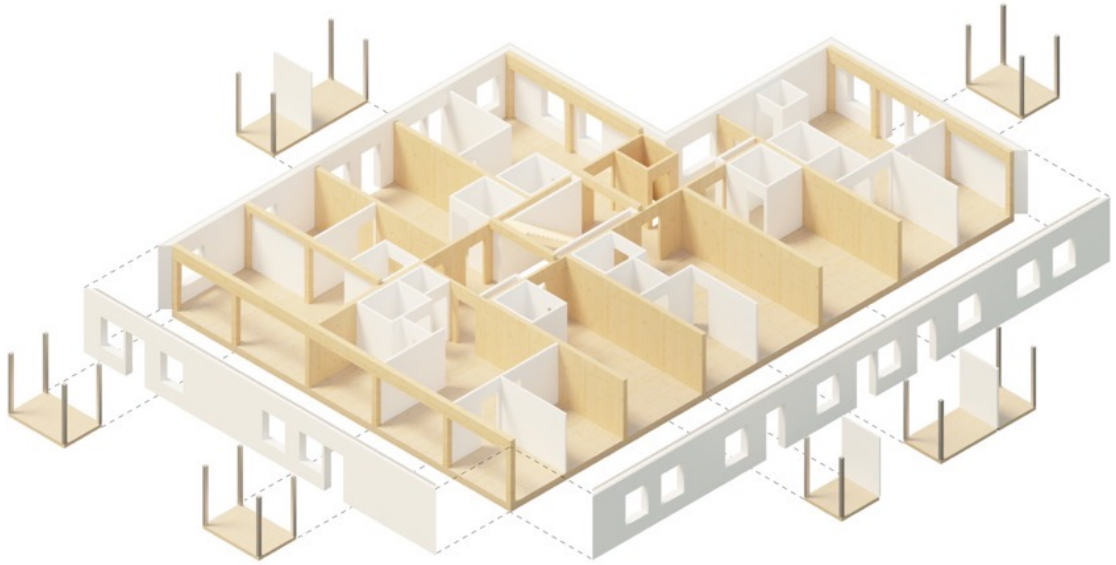
1. **A conversion design**: A direct conversion of the frame where concrete is substituted with CLT-elements
2. **A wood-optimized design**: A combination of different wood-based methods and technologies to maximize the level of industrialization to create an end result similar to the original, while acknowledging the initial preconditions of massive wood design.

Residential case study

The end result of the wood-optimized design was a frame type with wooden load-bearing walls, wood columns and beams, and efficient floor slabs from CLT.

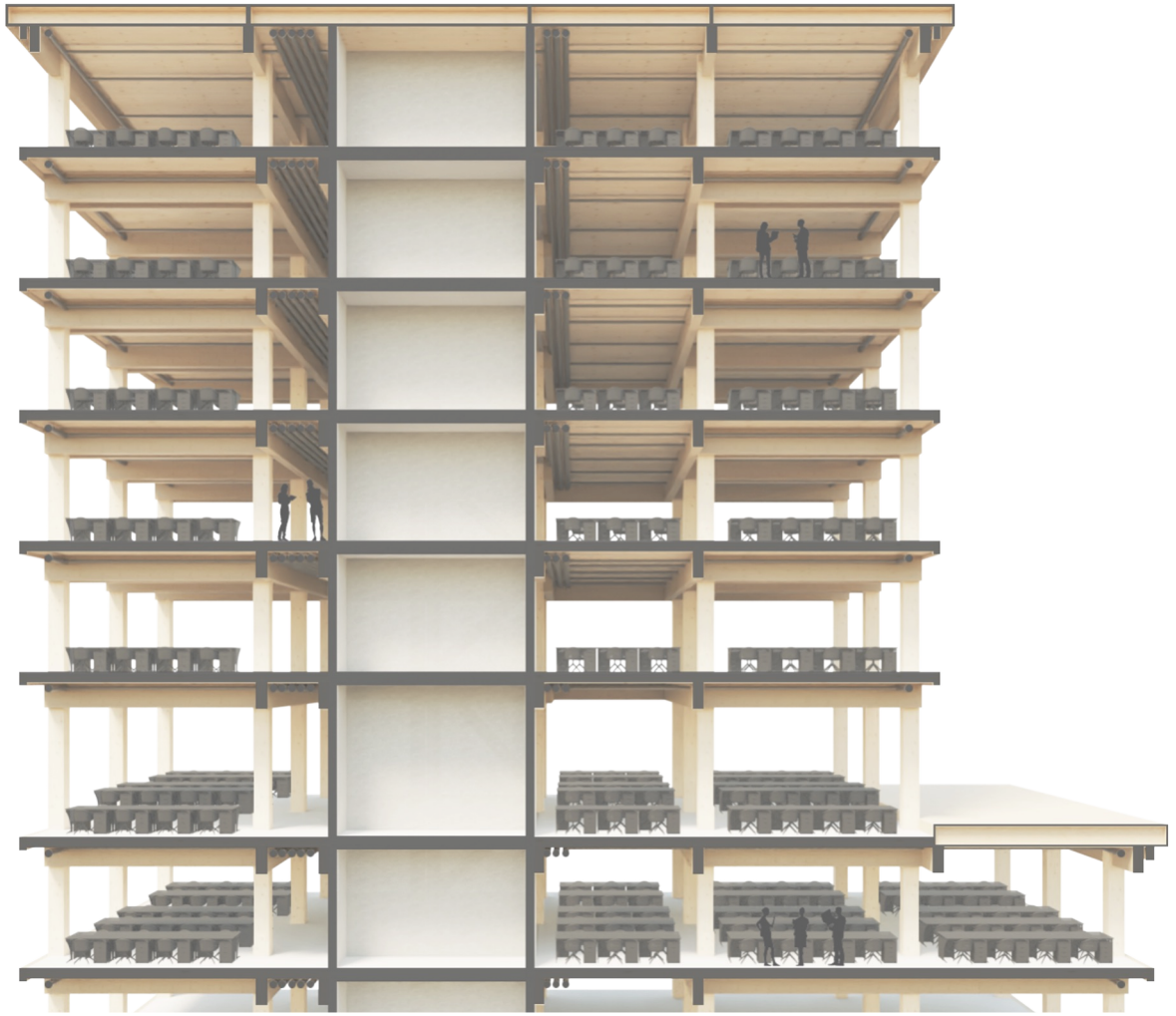
Non-load bearing exterior walls were designed to increase flexibility in design and on-site installation procedures.

The system utilized spans which were efficient for wood, without compromising the architecture.



Office building case study

The aim was to study material-related low carbon possibilities and solutions by reproducing a concrete office project with a massive wood and low carbon concrete frame.

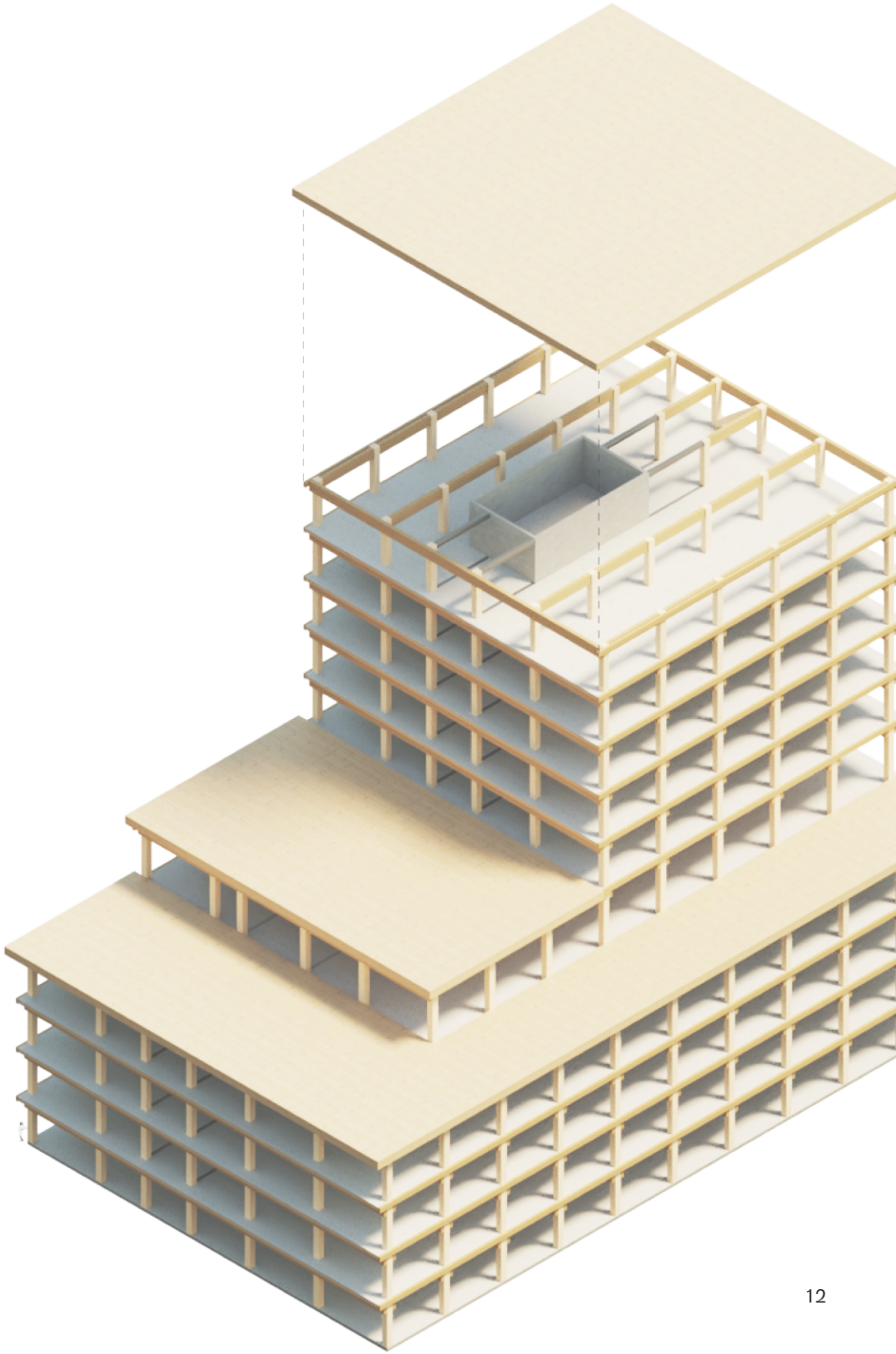


Office building case study

The study introduced a new type of an office building frame:

The main structure of the office space was designed of massive wood slabs, columns and beams. The strengthening core in the middle of the building with elevators, stairs and rest rooms is made of low carbon concrete. For the wooden office space, we found a grid of columns that suits well for a massive wood structure and simultaneously fulfils the needs of office use.

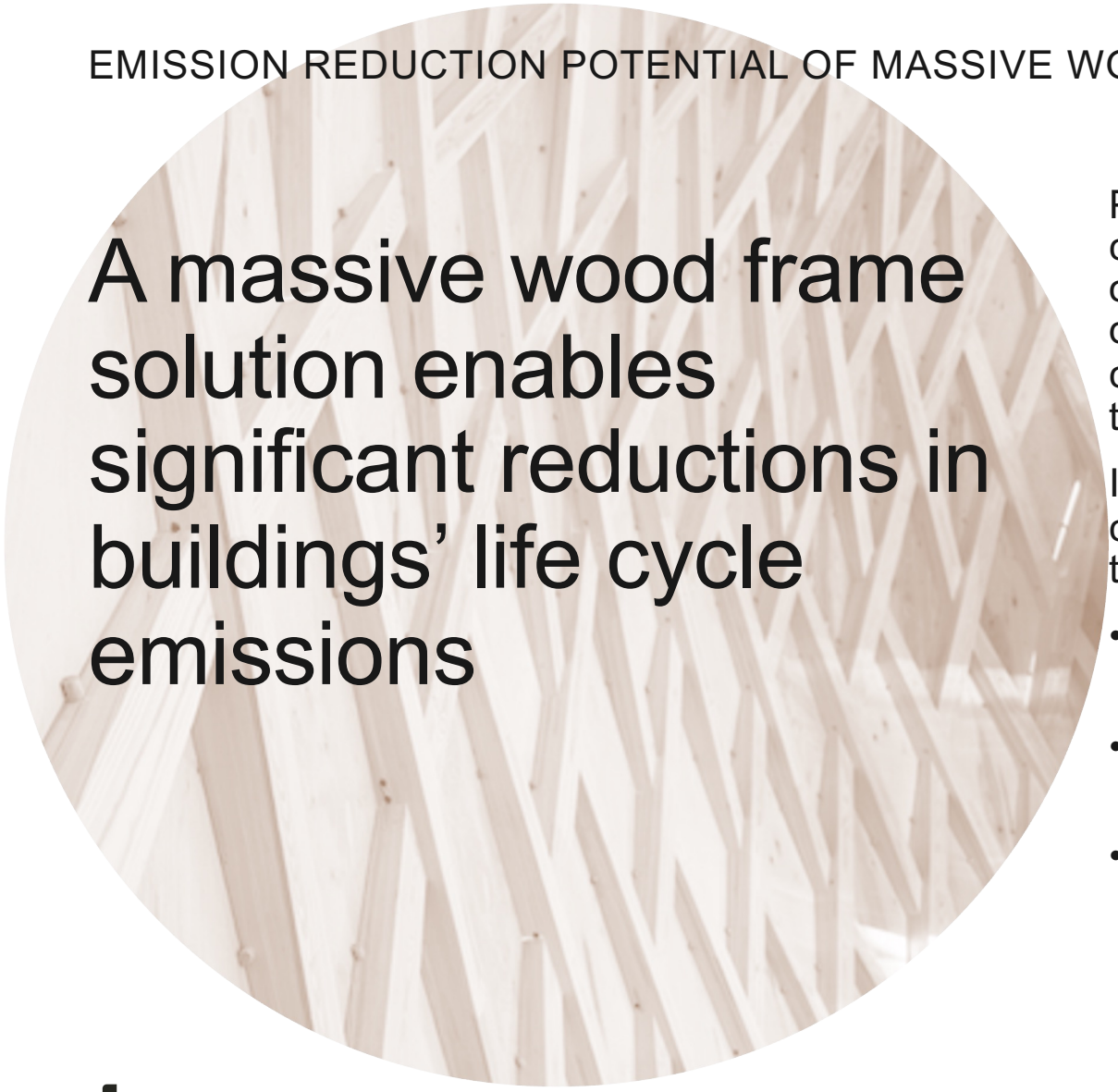
Studying alternative frame options enabled us to look at ways to reach efficient low carbon options. This solution co-developed between NCC, Stora Enso and Ramboll brings property investors and owners the option to choose a new alternative low carbon frame structure.



Conclusions from the **case studies**

- Conversions of building structures can give a quick estimate of the carbon footprint of a building. Nevertheless, a conversion doesn’t represent the final optimized solution, but can give a direction for designing a low carbon building.
- A cost-efficient, buildable and carbon footprint optimized solution was found by comparing different types of massive wood structures.
- A massive wood building project has an intensive design process in the beginning, but the chosen material can save time later on site.
- It is beneficial to optimize the layout of the building for massive wood spans.
- A massive wood building project requires intensive collaboration between parties throughout the process.

2. Emission Reduction Potential of Massive Wood



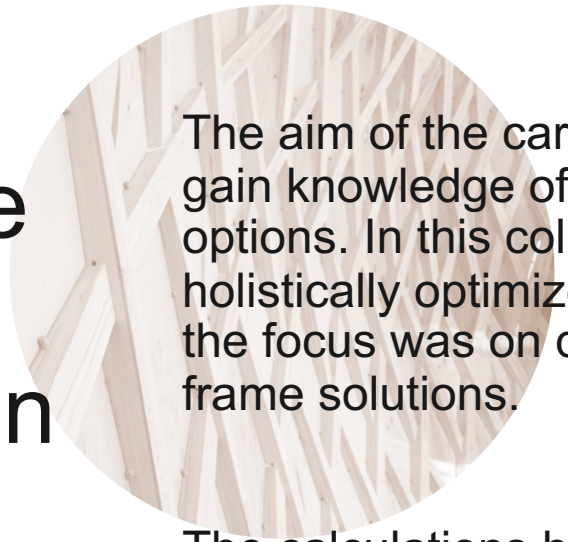
A massive wood frame solution enables significant reductions in buildings' life cycle emissions

Part of the collaboration development work was to gain comparable carbon footprint data from the whole life cycle of a residential and an office building designed with different wooden frame options. In both building type cases the different wooden frame options were compared to a typical concrete building.

In the collaboration we designed three different low carbon frame options whose emissions were compared to the similar concrete buildings. The three options were:

- a massive wood and low carbon concrete framed office building
- a wooden conversion design of the concrete framed residential building
- a wooden framed residential building that was optimised for wood from the beginning

A massive wood frame solution enables significant reductions in buildings' life cycle emissions



The aim of the carbon footprint calculations was to gain knowledge of the emissions of different frame options. In this collaboration the building was not holistically optimized towards low carbon, instead the focus was on developing optimal low carbon frame solutions.

The calculations have been conducted according to the **Method for the Whole Life Carbon Assessment of Building by Ministry of the Environment (version: 2021).**

Input data for the calculations

Concrete residential building input data:

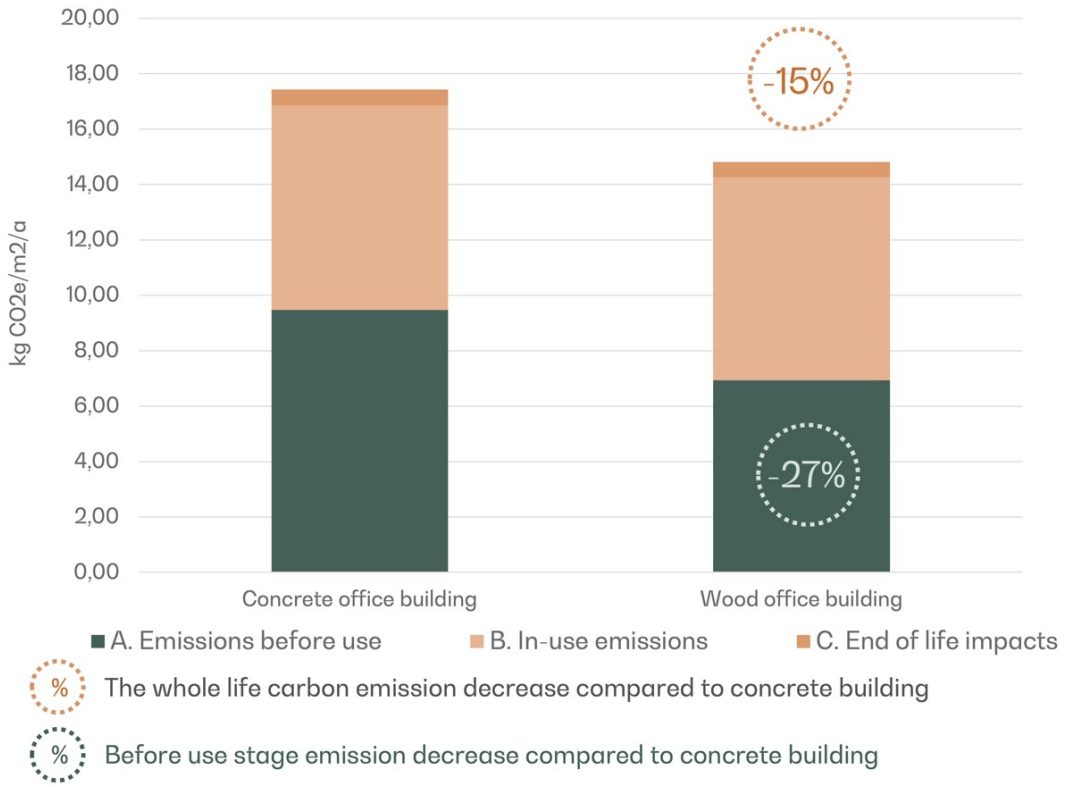
Building type	Residential building
Building year	2022
Location	Espoo
Gross floor area	2500 m2
Number of floors	6 (+ 1 basement floor)
Plot area	3789 rp-m2
Form of heating	Geothermal heating
Energy class	A
Calculated purchasing energy consumption	Electricity: 187MWh

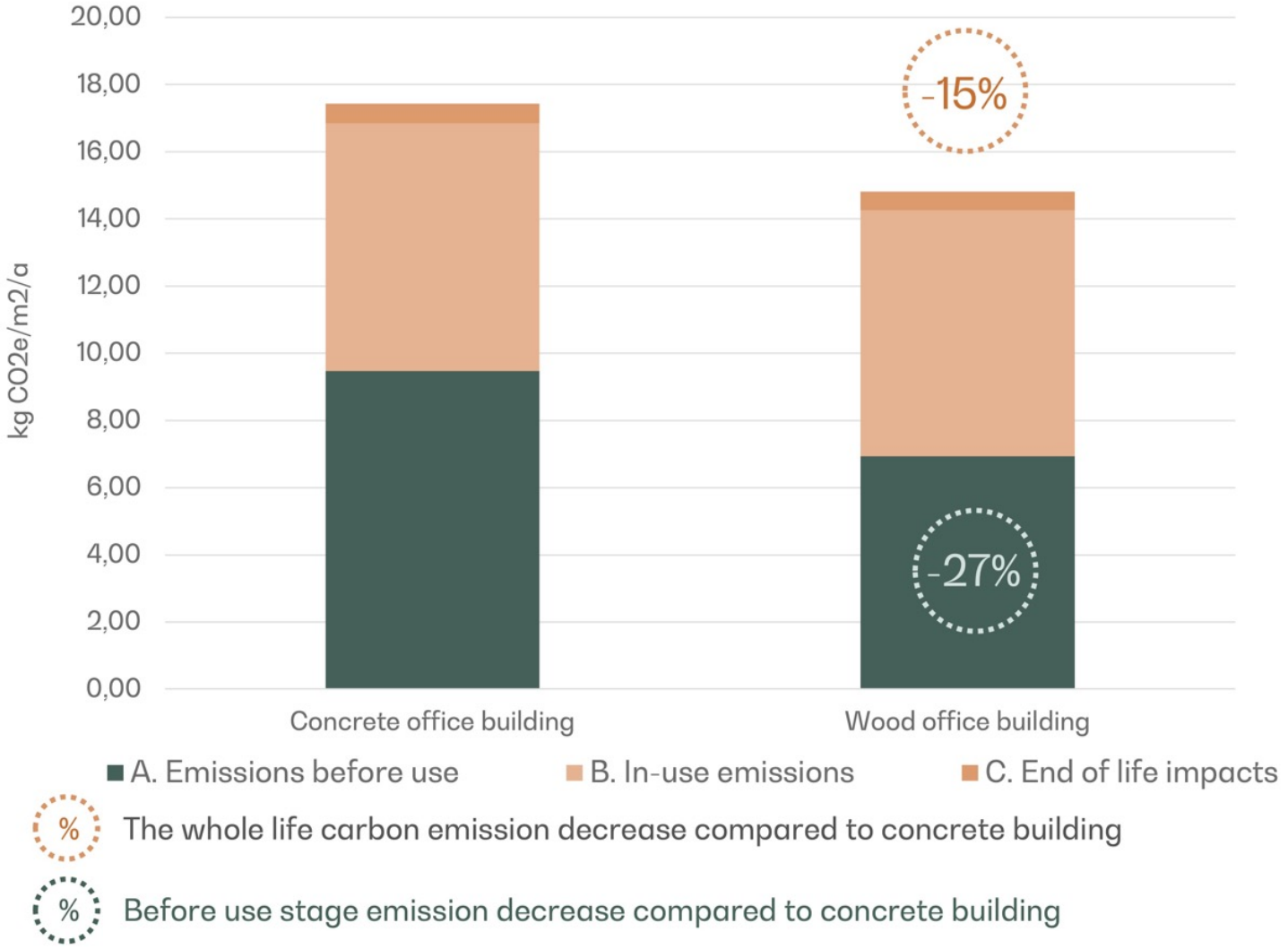
Concrete office building input data:

Building type	Office
Building year	2022
Gross area	16600 brm2
Number of floors	11
Form of heating	Geothermal and district heating
Energy class	A
Calculated purchasing energy consumption	Electricity: 768MWhDistrict heating: 493 MWhDistrict cooling: 102 MWh
Consequence class	CC3, CC2
Reliability class	RC3, RC2
Fire protection level	R120

Office Pilot - Frame solution comparison, concrete and wood

- The whole life carbon emissions of the wooden office building are 15% lower compared to the concrete building due to the use of low carbon materials.
- Looking at the pre-use phase emissions alone, the carbon footprint of the wooden office building is 27% lower than that of the concrete building.
- The design solution uses wood, low-carbon steel beams on the first floors, low-carbon concrete and concrete screed from low-carbon concrete products. The strengthening core in the middle of the building with elevators, stairs and rest rooms is made of low carbon concrete.

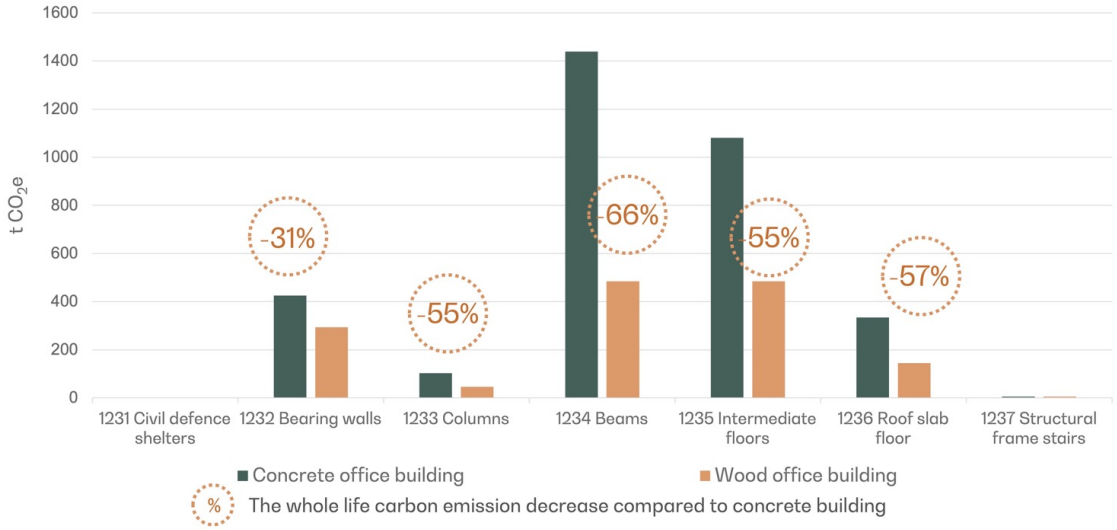


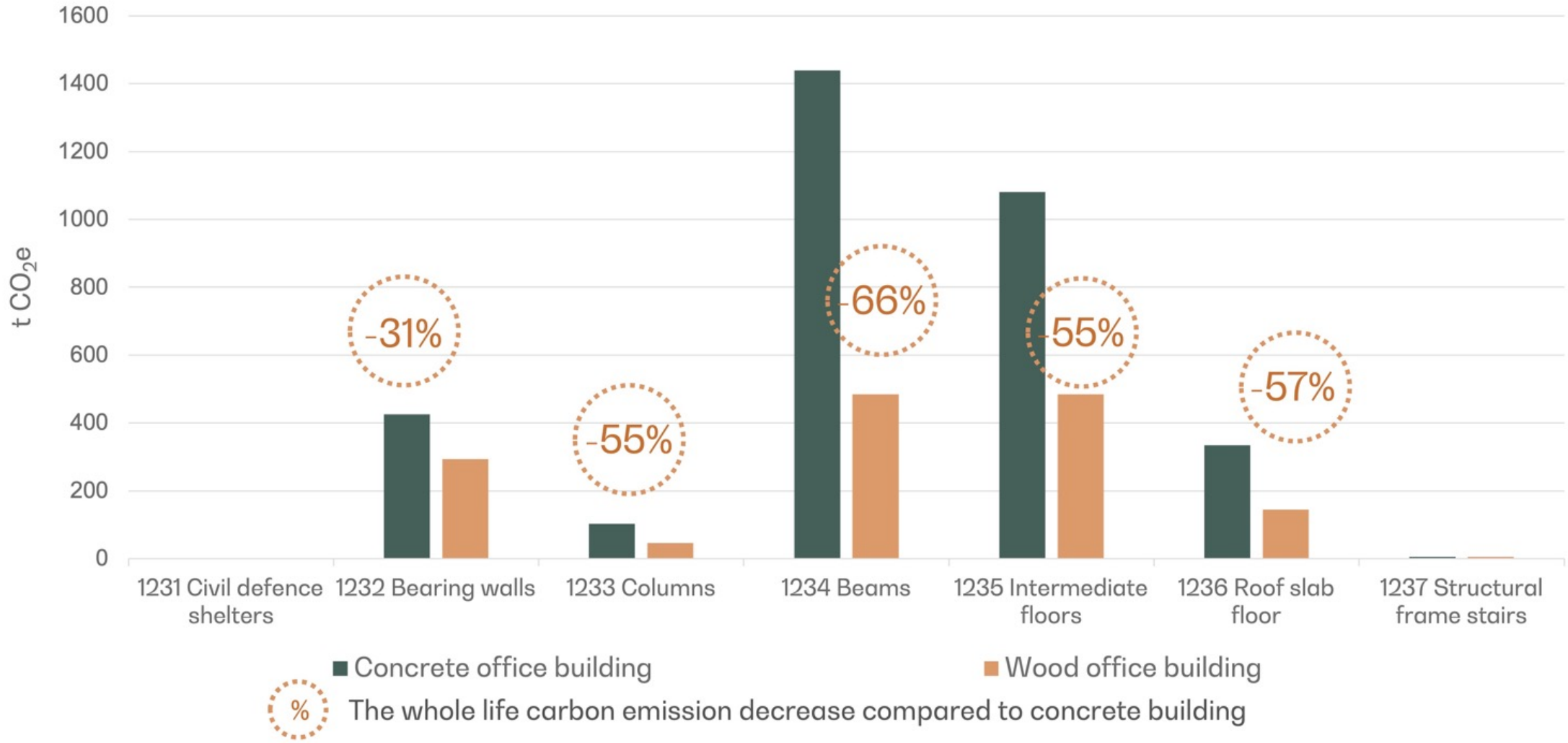


OFFICE PILOT - FRAME SOLUTION COMPARISON, CONCRETE AND WOOD

Office Pilot –, Product-related comparison, concrete and wood

- The greatest product-related reduction of carbon footprint is achieved by the use of low-carbon steel beams and glulam beams, which reduces emissions b 66% from those of the concrete-structured office beams.
- The carbon footprint can also be considerably reduced by replacing hollow-core intermediate floor beams with CLT-structured floors, which brings a 55% emission reduction.

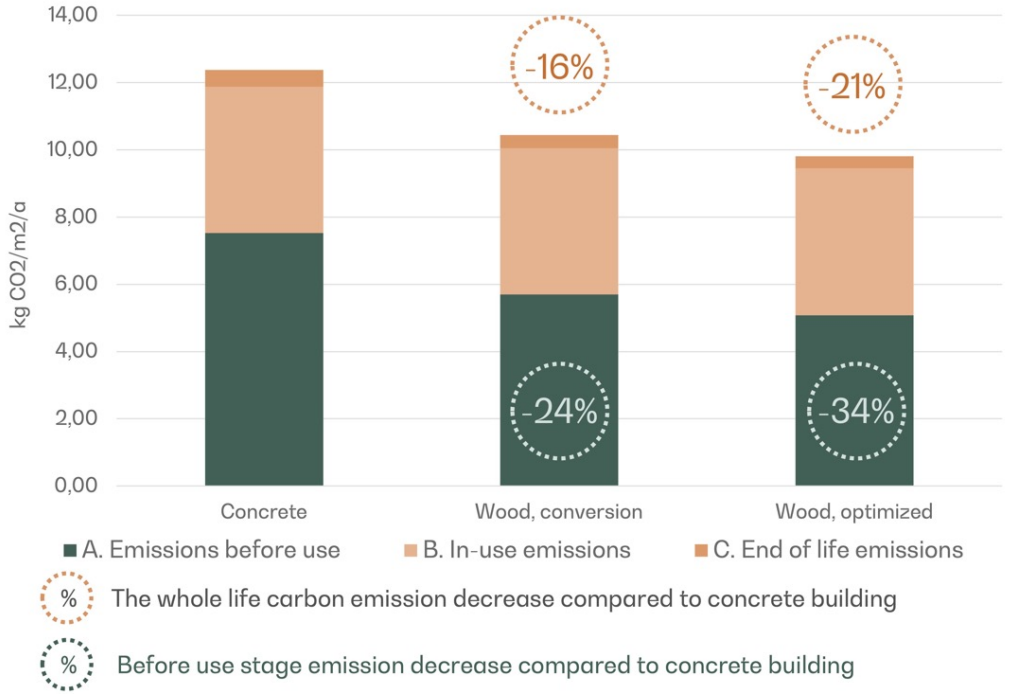




OFFICE PILOT - FRAME SOLUTION COMPARISON, CONCRETE AND WOOD

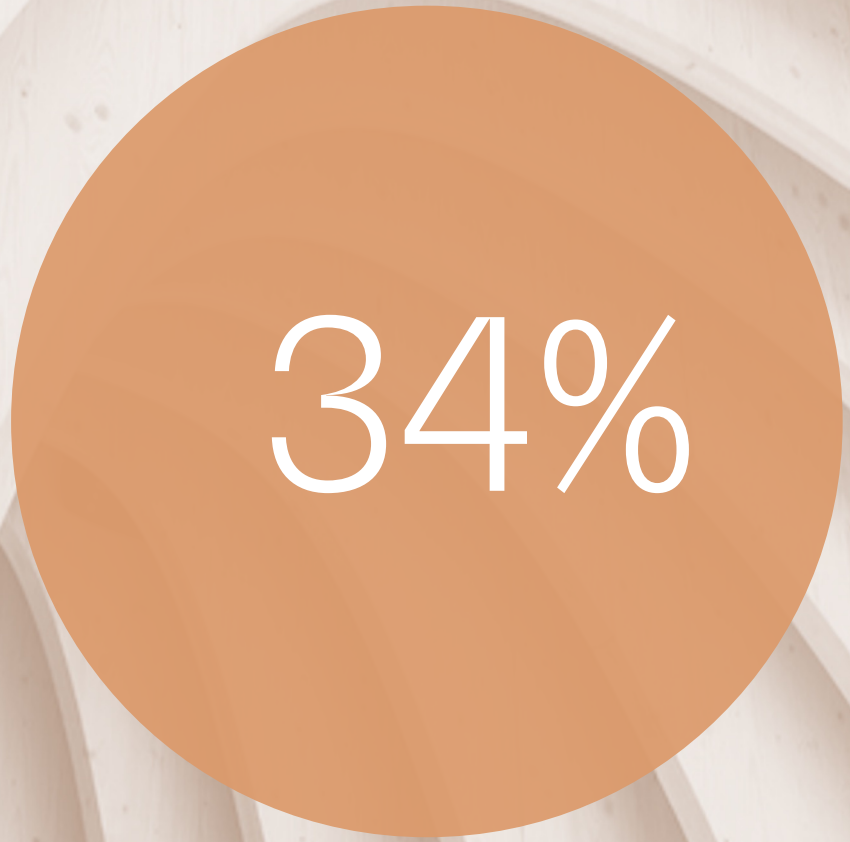
Residential Pilot – Frame solution comparison on concrete and wood

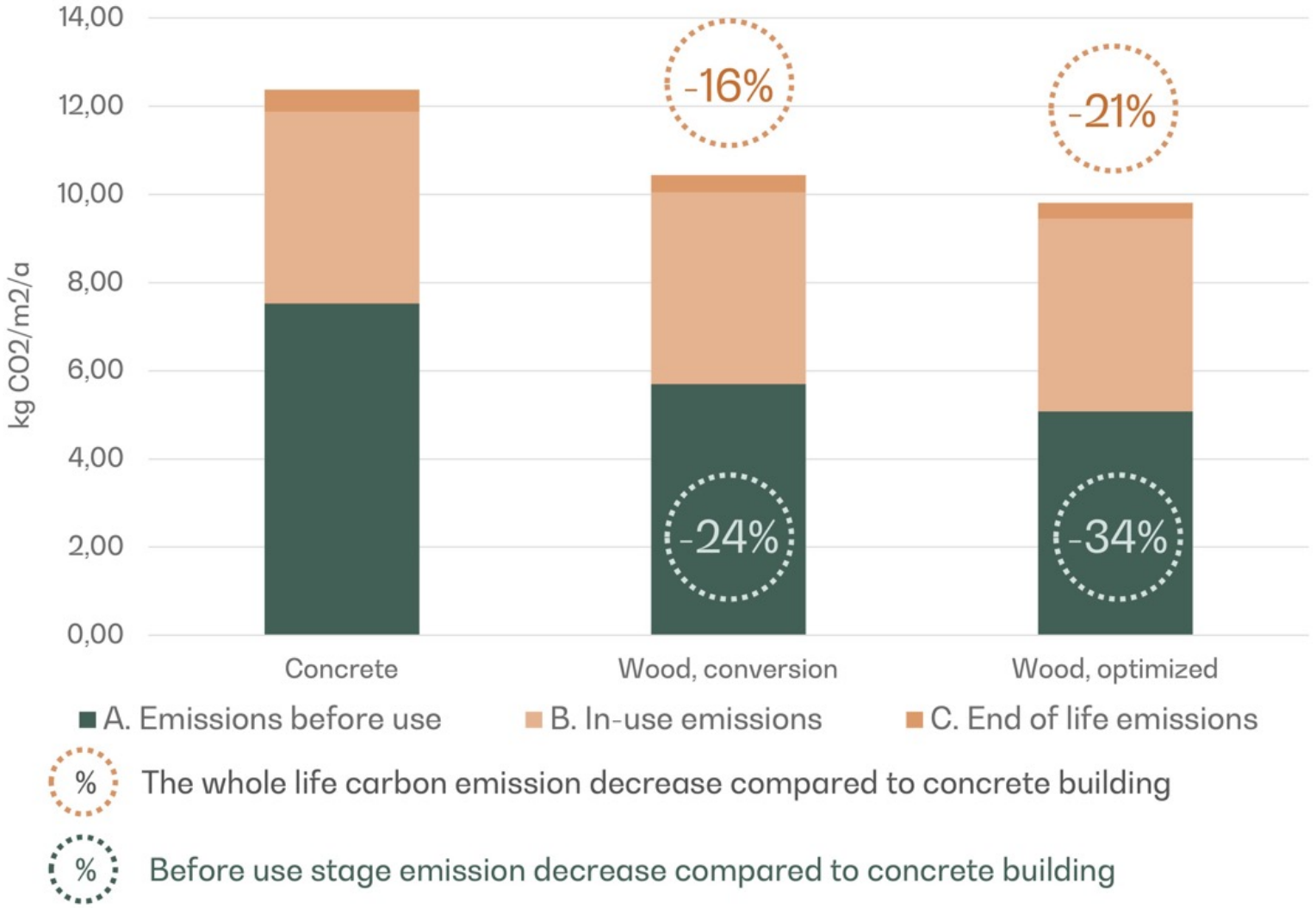
- The whole life carbon emissions of the wooden residential conversion building are 16% lower compared to the concrete building, while the optimized wooden building obtains 21% lower emissions than the concrete building
- The carbon footprint of the wooden conversion building has been reduced compared to the concrete building by using massive wood as the main material
- By optimizing the design based on wood's properties, an additional 5 percentage point reduction can be achieved compared to the wooden conversion building
- Looking at the pre-use phase emissions alone, the carbon footprint of the wooden conversion building is 24% and the optimized massive wood building 34% lower compared to the pre-use phase emissions of the concrete building



EMISSION REDUCTION POTENTIAL OF MASSIVE WOOD

Wooden frame solutions reduce the embodied emissions up to 34%





RESIDENTIAL PILOT – FRAME SOLUTION COMPARISON ON CONCRETE AND WOOD

Residential Pilot – Product-related comparison on concrete and wood

- The carbon footprint of an optimized wood-structured residential building is considerably lower than that of a similar concrete-structured building. Replacing the hollow-core intermediate floor slabs with CLT-structured floors brings a 70% emission reduction.
- The second largest product-related emission reduction is achieved using CLT-structured walls which allow lowering emissions by 71% from those of concrete-structured load-bearing walls.

EMISSION REDUCTION POTENTIAL OF MASSIVE WOOD

The greatest product-related emission reduction can be achieved by replacing hollow core slabs with CLT intermediate floors leading to 70% lower emissions within the product category

RESIDENTIAL PILOT – PRODUCT-RELATED COMPARISON ON CONCRETE AND WOOD

Conclusions from the **emission calculations**

- The results prove that wooden frame solutions have a significant impact on the building's carbon footprint, reducing the embodied emissions up to 34%
- The greatest product-related emission reduction can be achieved by replacing hollow core slabs with CLT intermediate floors leading to 70% lower emissions within the product category
- In addition to lower emissions, massive wood solutions store carbon throughout a building's lifespan increasing the carbon handprint of the buildings
- Early-phase value chain wide collaboration enables optimization of the design, which can lead to better low carbon solutions and lower emissions

3. Value Chain Collaboration

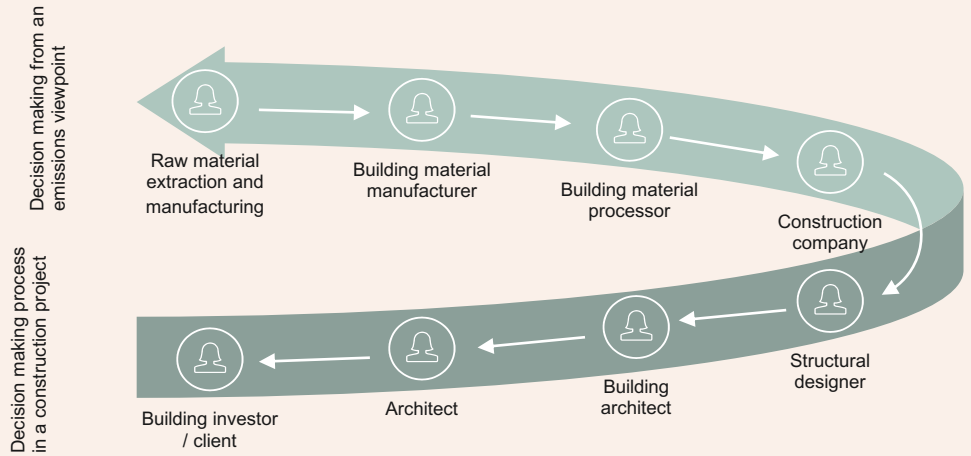
Benefits for the construction industry

1. Improving visibility and availability of low carbon solutions
2. Early-phase collaboration enables efficient design
3. Enhanced emission control in the building design phase
4. Fast-track to optimal solutions
5. Long term business value creation

1. Improving visibility and availability of low carbon solutions

The choices of building materials that affect the emissions most are made early on in the decision-making process by the client. However, a considerable part of the emissions are created in material production and manufacturing. Since the decision-making flow and the data on emissions go in different direction in the value chain, the needed emission data for making low carbon decisions may not be available at the time of decision. As the construction value chain consists of many different actors, gathering the emission data and analysing it into actionable outcomes is difficult.

DECISION MAKING AND EMISSION INFORMATION FLOWS



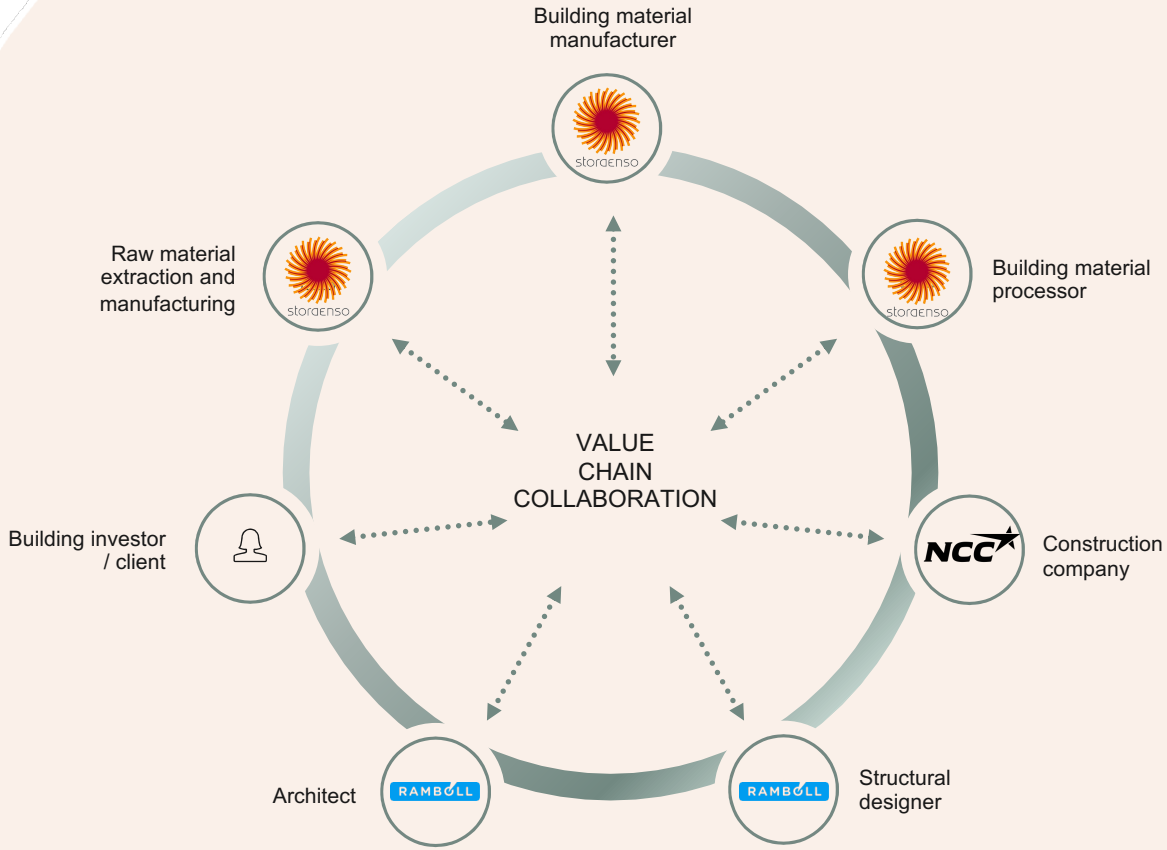
Applied from: Finnish construction industry's carbon neutrality roadmap to 2035

VALUE CHAIN COLLABORATION

1. Improving visibility and availability of low carbon solutions

Value chain wide collaboration enables a faster and a more transparent information flow between the different parties of the decision-making chain, since they are in direct contact with each other. Only through multi-party collaboration where that data is openly shared, we are able to create well-rounded options for end customers efficiently.

INFORMATION FLOW AND DECISION MAKING IN VALUE CHAIN COLLABORATION APPROACH



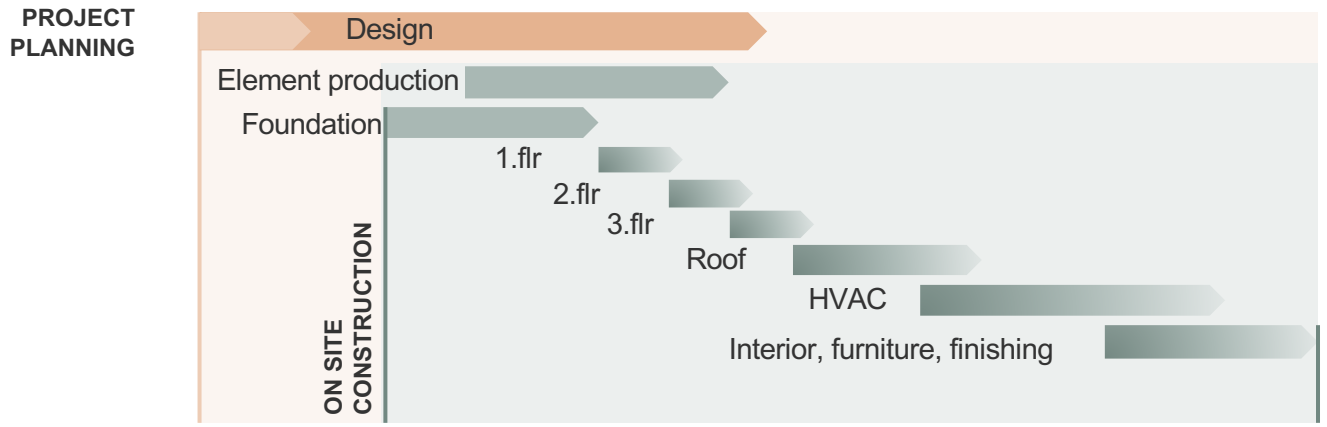
VALUE CHAIN COLLABORATION

2. Early-phase collaboration enables efficient design

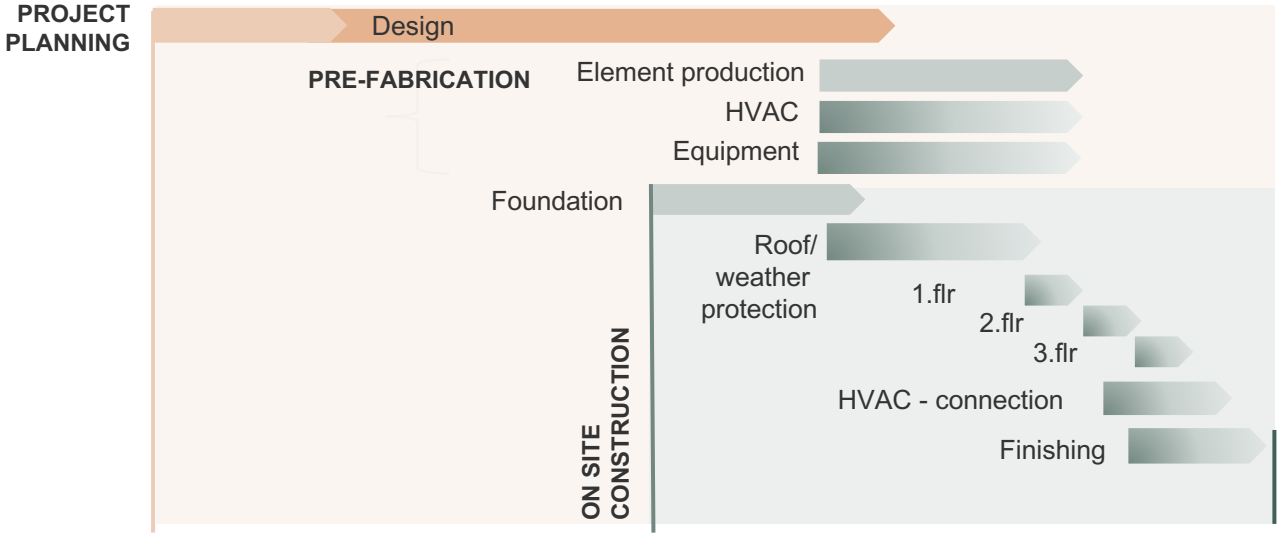
- An industrial massive wood construction process looks different from a traditional industrial construction process in that the design phase takes a longer time.
- The compatibility of massive wood elements and other materials must be verified by design prior to starting the element production.
- When the massive wood supplier, the building designer and the general contractor work together from the very early stages of the design, this will ensure that critical information on the design solutions is shared and the design can proceed more efficiently.
- A closer collaboration with multiple actors in the value chain helps the end customer recognize the features of massive wood as a building material.

VALUE CHAIN COLLABORATION

TRADITIONAL INDUSTRIAL CONSTRUCTION



INDUSTRIAL WOOD CONSTRUCTION (PRE-FAB)



VALUE CHAIN COLLABORATION

3. Enhanced emission control in the building design phase

Regulation development is pushing the construction industry to track the emissions from a building project, but the tools, calculation methods and methodologies for the tracking are still under development. Early collaboration and provision of information across the entire value chain make it easier to access the necessary emission data, to compare and make decisions on low carbon options.

VALUE CHAIN COLLABORATION

4. Fast-track to optimal solutions

A value chain-wide collaboration helps companies solve challenges and dispel prejudice towards the use of massive wood as a construction material. An outside-in view coming from other organizations may fast-track the way companies develop their own processes and operations. Massive wood as a construction material is not necessarily the best choice in all cases, but when expertise is available from many different parties to the value chain it is easier to spot where and how massive wood can be the perfect low-carbon option. As it is a fairly new material in industrial construction, the collaboration between the key players and experts helps both construction companies and their customers in considering it as the main or hybrid frame material option.

VALUE CHAIN COLLABORATION

5. Creating long-term business value

- Value chain-wide collaboration is unique in the building industry.
- Companies are usually focused on their own offering in the construction ecosystem, be it material manufacturing, construction management or building design. Working closely together with other actors can unlock new business potential.
- This kind of joint business development also creates value over a longer term than a single plot competition or an alliance founded for a single building project.

Project Partners

“Thanks to the collaboration between the different contributors to the value chain, NCC is now more capable of proposing their clients to build massive wood framed buildings”, Pekka Kiuru, Head of Development, NCC

“The results of the collaboration revealed that a building’s carbon footprint can be significantly reduced using the already existing massive wood solutions”, Tomi Jussila, Stora Enso’s Sales Director, Building Solutions

”The cost-efficiency of wood construction is mostly based on high prefabrication degree of the components in which the structural design and multi-disciplinary approach play a critical role”, Jaakko Paloheimo, Wood Construction Specialist, Ramboll

”Multi-company collaboration between major companies requires a neutral orchestrator to take the lead: thereby it is made sure everybody works towards the common goal, that everyone takes active part in the activity and innovates together”, Marika Määttä, Head of Combient Pure.

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