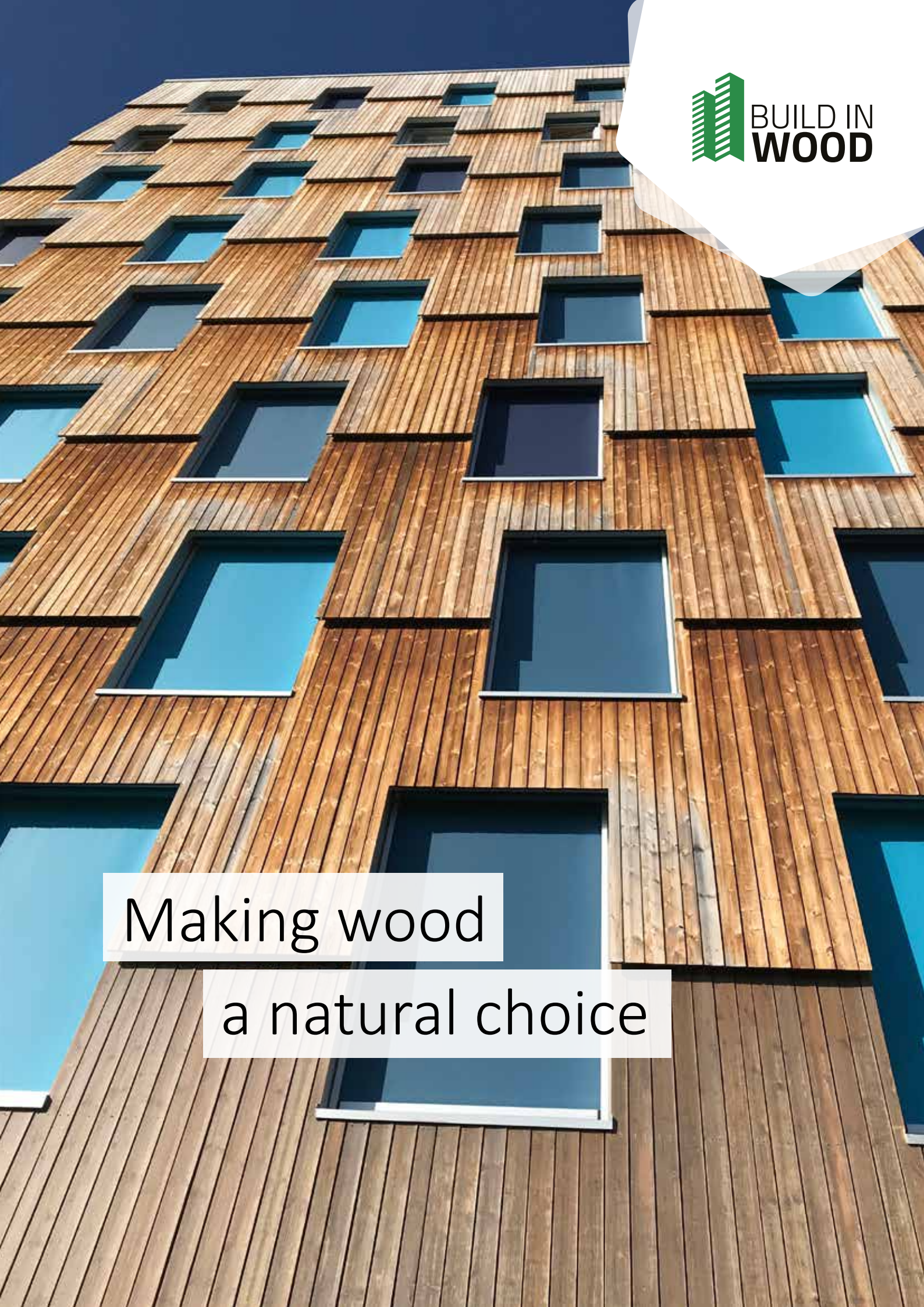
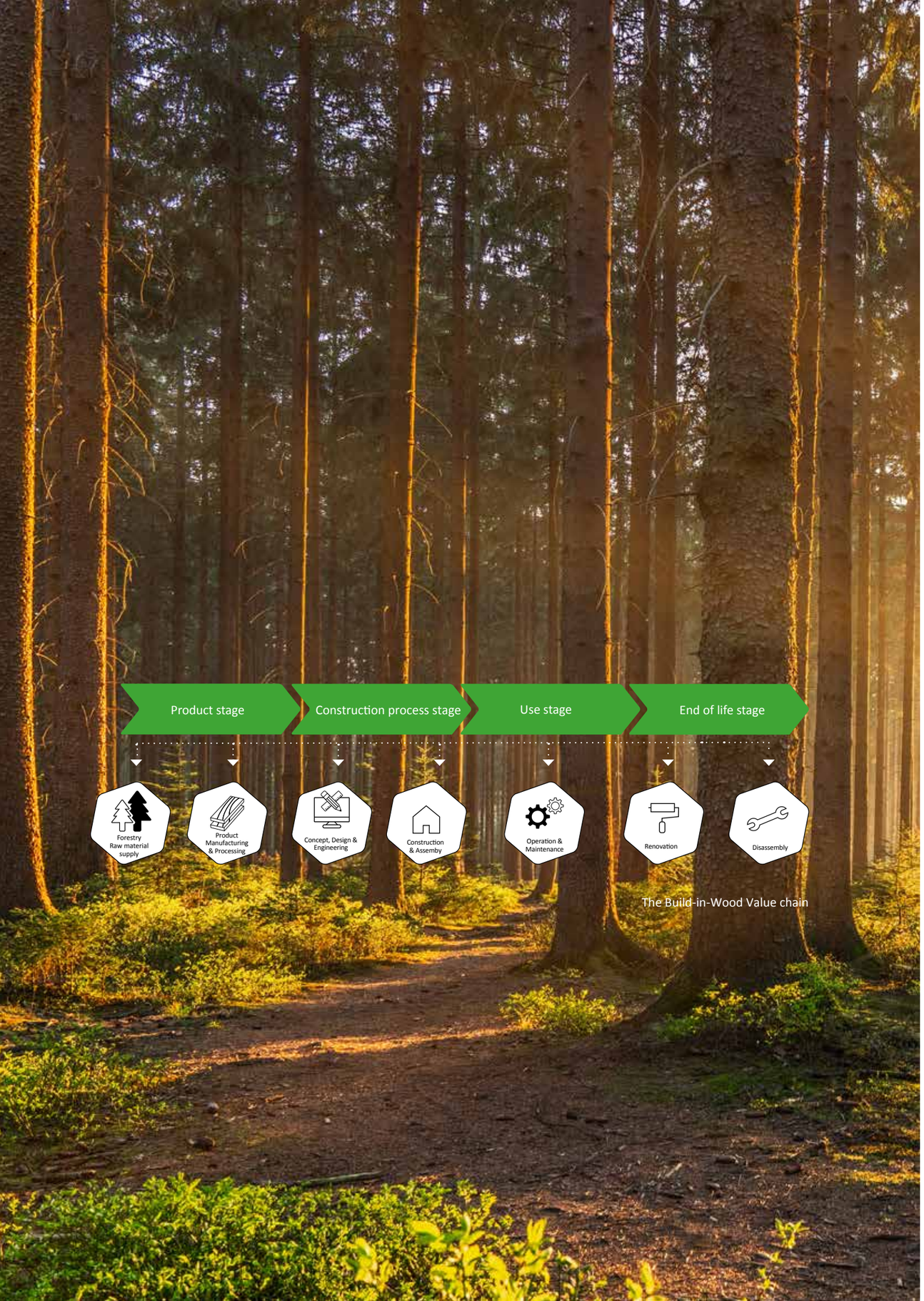


BUILD IN WOOD

Making wood a natural choice



The Build-in-Wood Value chain

Foreword

This exploitation booklet contains selected key results from Build-in-Wood – a European Horizon 2020 project running from 2019-2024. As coordinators of Build-in-Wood, we are immensely proud of the achievements the consortium has accomplished over the course of the project. From the very beginning, there's been a unique spirit of cooperation and collaboration within the consortium coupled with high ambitions and great enthusiasm for the project to make a real difference for wood construction.

We would like to express our gratitude to the EU for co-funding Build-in-Wood. Indeed, we believe European research innovation projects are unique in the World in the way that they provide opportunities to unite different value chain stakeholders across many countries, which makes for highly innovative environments.

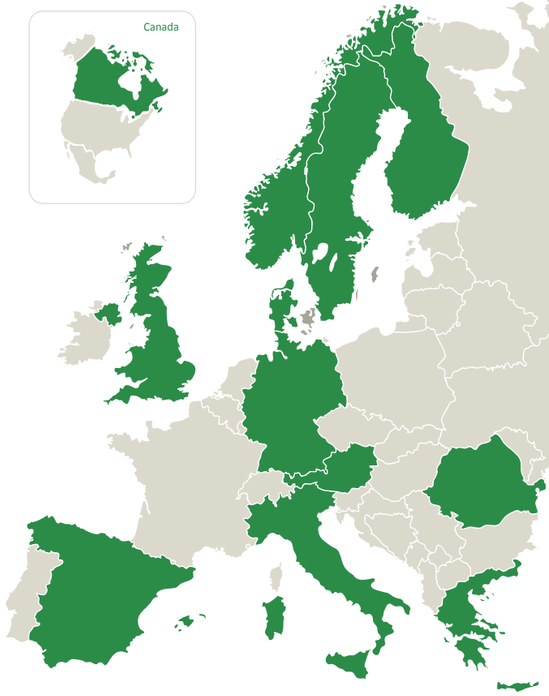
Last, but certainly not least, we would like to express our deepest thanks to the consortium for their hard work, enthusiasm and good spirits during the project. We will certainly miss the many good 'colleagues' we have gained during the project and wish all the Build-in-Wood partners the best for the future.

Anders Kjellow
Centre Project Manager

Niels Morsing
Director

Wood and biomaterials,
Building and construction
Danish Technological Institute

Content



www.build-in-wood.eu

Build-in-Wood

Sustainable Wood Value Chains for Construction of Low-carbon Multi-storey Buildings from Renewable Resources

Welcome to the Build-in-Wood Project booklet. As part of the Horizon 2020 initiative, the Build-in-Wood project has successfully brought together a consortium of 21 partners from 12 countries, including Norway, Finland, Sweden, the UK, Denmark, Germany, Austria, Romania, Italy, Greece, Spain, and Canada. With a substantial funding of 10 million euros, this project has effectively tackled the global and European challenges of reducing greenhouse gas (GHG) emissions from the construction sector.

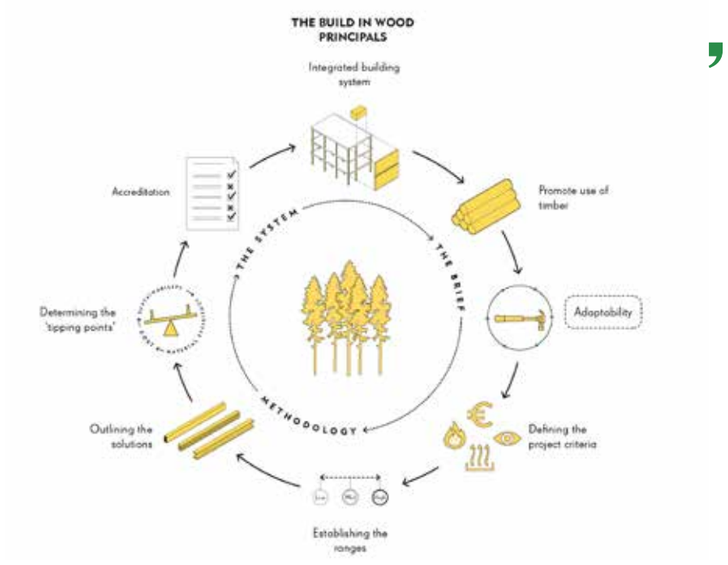
Through our efforts, Build-in-Wood has developed a sustainable and innovative wood value chain for constructing multi-storey wood buildings. Our ambition to make optimized and cost-effective wood construction methods a common practice in the European construction sector has been realized.
The project has addressed these challenges through the innovative development of materials, components, structural systems, and façade elements for multi-storey wood buildings, suitable for both new constructions and retrofitting. These developments have been rigorously tested, piloted, and fully documented, facilitating eventual market uptake. Active engagement with selected cities has strengthened urban-rural connections and promoted the use of wood in construction.

FACTS:
Project No.: 862820
Duration: 09/2019 - 08/2024
Total Budget: 10 Mio Euro
EU Funding: 8.6 Mio Euro

Build-in-Wood Building System

The Build-in-Wood consortium has developed an open-source building system designed to use generic products and widely available materials to safeguard against issues of procurement and competitive tender.

The Build-in-Wood system consists of a kit of variable components, which can be tailored to achieve the range of performance criteria typically required for residential or commercial buildings of between five and ten stories across Europe. Optimised for material efficiency and designed for maximum adaptability, the system comprises a structural frame and a non-structural façade, which can be used both holistically and independently to encourage re-use, retrofit and extension of the existing building stock.



Kirsten Haggart, Associate Director
Waugh Thistleton Architects

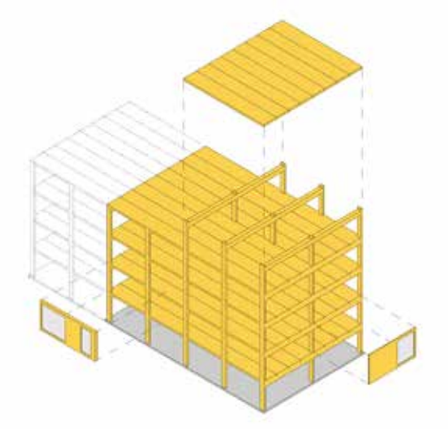
Build in Wood harnesses the collective power of in-depth research form across the industry to deliver a system that streamlines and simplifies the transition to a low carbon construction industry.

THE STRUCTURAL SYSTEM

The Build-in-Wood structural system is designed as an engineered timber post and beam frame. It offers flexibility of internal configuration and material efficiency, allowing more multi-storey buildings to be built using timber. The adaptability of the internal layout is essential when designing buildings with different functions. By allowing spaces to be reconfigured to change or modify their function, the Build-in-Wood structural system helps to achieve and extend the financial and environmental longevity of buildings. The structure is easily adapted to a range of site-specific requirements without compromising the efficient use of space, and the simplicity and robustness of the system. Connections have been identified and/or developed for all major interfaces of the the structural system which predominantly uses widely available and certified brackets and screws. Fire and acoustic/vibration performance have been considered in the design of both connections and wall/floor assemblies.

THE FAÇADE SYSTEM

The Build-In-Wood façade system is based on the use of fully prefabricated panels, consisting of a lightweight timber frame substructure to which variable layers are applied, both internally and externally, that can be tailored to meet the required thermal, fire and acoustic performance levels of a given project. The panels are non-load bearing and are only expected to carry their own weight and wind load. The system has been designed to eliminate the need for scaffolding (depending on the cladding type) as this has been identified as a key factor in increasing safety and reducing installation time and costs. The Build-in-Wood cladding panels are 'single storey' and horizontally oriented, meaning they can be delivered to site in their 'permanent' orientation, maximising their level of prefabrication.



Design-Guide
„Building System"

Available Documents:

- Booklet "System Guide"
- Booklet "Component Selector"
- Booklet "Assembly Manual"

Enhanced connection systems for wood construction

The developed “Build-in-Wood Building System” opened up the possibility to verify the limit and advantages of existing connection solutions of consortium partner Rothoblaas. The company applied for an international patent for two new products.

The proposed building system is suitable for both residential and office type buildings including multi-story buildings. It was found that the interlocking system is the connection that offers the largest number of benefits. However, the current products did not address the high resistance needed for large post and beam systems with the adequate tolerance.

Eng. Alberto Di Paolo
Rothoblaas

Innovation is not just about scaling up, but about creating solutions that precisely fit the purpose. LOCK and ALUMEGA are the ultimate solutions for timber beam connections that take post and beam structures to the next level

CONCEALED TIMBER-TO-TIMBER AND TIMBER-TO-CONCRETE CONNECTION: LOCK-CONNECTORS

The LOCK-connectors can satisfy multiple needs, even for more complex structures. Until now, LOCK-connectors were used for simple pergolas or attics. Build-in-Wood enabled the development of new LOCK-models:

> LOCK T MINI is the innovative hook plate for completely concealed timber-to-timber joints. It can be easily disassembled, is ideal for the construction of small temporary structures and can be used concealed even with elements of reduced section.

> LOCK T MIDI is an innovative hook plate for concealed timber-to-timber joints, offering exceptional strength. It is easily disassembled, ideal for small structures, and suitable for use with reduced section elements. Perfect for post-and-beam systems, carports, pergolas, and slabs, both indoors and outdoors.

> LOCK FLOOR is the innovative aluminium profile for timber-to-timber and timber-to-concrete joints that provides exceptional strength. Quickly removable, it is ideal for the construction of CLT floors with support on concrete or CLT walls. Also suitable for hooking to the timber structure of prefabricated infill walls, stair ramps or canopies.

> LOCK C is the aluminum alloy concealed connector for the construction of timber-to-concrete joints easy to install. The hooking system is ideal for quick removal of timber beams for seasonal requirements.

PINNED CONNECTION FOR POST AND BEAM: MEGALOCK AND ALUMEGA CONNECTORS

This product standardizes beam-to-beam and beam-to-column connections for post-and-beam systems, including large spans. Modular components and various fastening options work with timber, concrete, or steel. These connectors offer the highest installation tolerance among high-capacity, off-the-shelf timber connectors, allowing for ±4 mm along the secondary beam axis. Easily installed and fully concealed, they provide excellent fire resistance. Suitable for residential and office buildings, including multi-story structures, this system offers maximum adaptability for internal use

With ALUMEGA post and beam connector, the theoretical behaviour assumed in the design of timber-to-timber connections is enabled: It acts as post and beam connectors that allows free rotation of the beam at the ends. In case of earthquake or wind, the connection follows the column rotation preserving shear resistance for gravitational loads from the floor and reducing structural damage. The possibility of placing several modules side by side makes it possible to solve all connections on timber, concrete and steel.

IMPACT:

Based on the developments in Build-in-Wood Rothblaas aims to be the leader of Post and Beam systems with a complete range of products for this construction system. The new developed connectors are important strategic solutions for completing this mission.

Newly developed connection solutions

Lock T Midi Concealed Timber-To-Timber Connector

Lock T Mini Concealed Timber-To-Timber Connector

Lock Floor Joint Profile For Clt Panels

Alumega Pinned Connection For Post And Beam

Rothoblaas Catalogue:
Plates and connectors for timber 2024

Build-in-Wood Performance documentation

Optimized systems for multi-storey timber construction

The project centred on the performance characterization, validation, and thorough documentation of cutting-edge technological solutions nearing market readiness. Emphasis was placed on comprehensive documentation and validation of both the developed systems and the building scenarios they were designed for. The materials, components, and building systems created during the project underwent testing and documentation, ensuring their reliability and effectiveness. This approach aimed to deliver a complete and validated package, ready for real-world application.

For the developed building materials and components, five areas of technical performance have been documented and validated: mechanical performance, fire performance, acoustic performance, thermal performance and indoor climate performance.

Bernhard Bredl, Marketmanager
Knauf Gips KG

Our involvement in the "Build in Wood" project was part of our growing commitment to the timber construction industry. The results achieved in the project will be used in the further development of our timber based building systems for timber construction.

Testing the fire performance

Testing the acoustic performance

MECHANICAL PERFORMANCE

The Build-in-Wood structural system relies primarily on established products and solutions, with known mechanical properties for the Build-in-Wood posts, beams, and other structural elements. Optimization efforts highlighted the necessity for suitable connections within the structural and stabilizing building system. Various connections, including post and beam connections as well as those in the stabilizing core, were rigorously tested for different properties. Additionally, the bonding strength of several adhesives was evaluated, with a particular focus on the potential use of biobased adhesives in timber construction products.

FIRE PERFORMANCE

The fire behavior of several materials and construction members, developed in the frame of the Build-in-Wood project, was investigated by means of “encapsulation”, “small scale furnace” and “timber connection” fire tests.

ACOUSTIC PERFORMANCE

Pure massive timber constructions lack the heavy weight of concrete or masonry and the benefits of a high critical frequency and a mass-spring-mass-system well above the resonance frequency. Therefore, some add-ons are needed for sufficient sound reduction.

THERMAL PERFORMANCE AND BUILDING PHYSICS

The dynamic thermal and hygrothermal behavior of two wall systems have been investigated, a stud-wall and a CLT wall, with various nature-based insulation material and exterior cladding. Furthermore, the role of natural convection in the air layer (cavity) behind the exterior cladding has been studied.

INDOOR CLIMATE PERFORMANCE

A biobased glue was developed (see page 15). Emissions according to EN 717-1 of the new glue system compared to benchmark reference glue have been tested.

Dionysis Kolaitis
National Technical University of Athens

The multi-faceted performance testing of the construction materials and systems developed within the "Build-in-Wood" project, highlighted their significant advantages and, at the same time, laid the groundwork for adapting certification testing procedures to the unique features of innovative timber-based construction solutions.

Re-used wood in cross laminated timber (CLT)

Construction industry faces a significant issue with wood waste. With the growing focus on the circular economy and better utilization of raw materials, it is crucial to address this challenge. Despite this, most industries still heavily rely on primary resources, and there are no regulations in place for documenting re-used wood, creating barriers in standardization.

Build-in-Wood investigated the potential use of reused wood for Cross Laminated Timber (CLT) by collecting materials from a Norwegian waste plant. The gathered materials included mechanical fasteners such as screws, nails, and brackets, as well as timber framing and construction formwork materials. To assess the viability of these materials, small-scale CLT prototypes with reused wood in the middle layer underwent 4-point bending tests. The mechanical testing revealed no signs of weakness in terms of strength, stiffness, or bonding quality, indicating that reused wood can be effectively utilized in CLT production without compromising structural integrity.

FUTURE EFFORTS

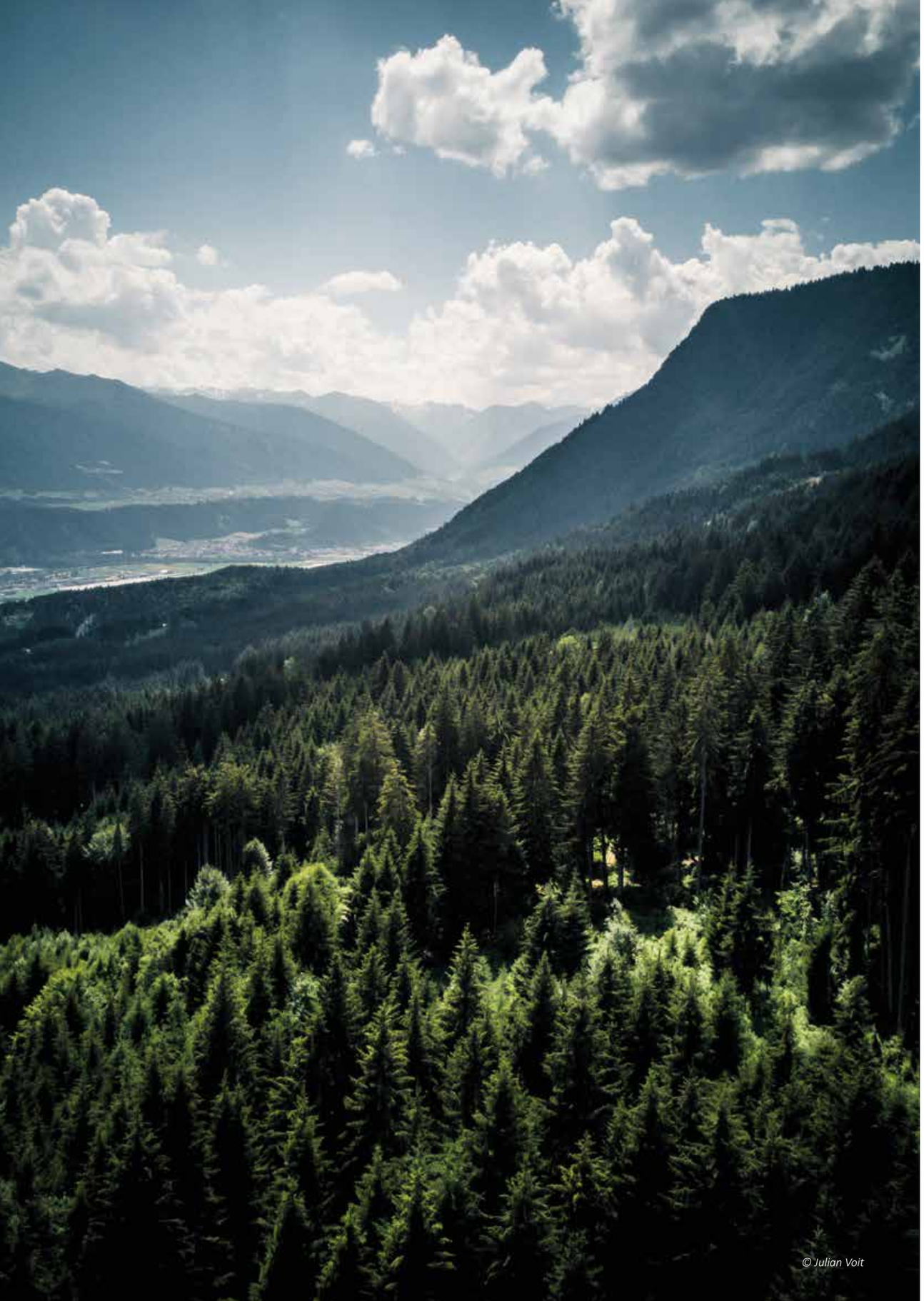
Future efforts should focus on ensuring that reused wood complements, rather than replaces, primary raw materials. This includes developing efficient cleaning techniques, implementing strength-grading documentation, and exploring finger-jointing short pieces. To start, low-hanging fruits such as non-loadbearing applications and transverse layers in CLT should be utilized. A comprehensive approach must also consider environmental impact, costs, industry effects, and social aspects.

Karl-Christian Mahnert, Senior Scientist. Norwegian Institute of Wood Technology

> *Build-in-Wood has been at the forefront of setting the issue of reclaimed timber as complementary material to primary raw material on the wood research agenda. The topic has received a lot of attention in extensive national projects in Norway, where both technological and preliterate aspects are addressed.*

Prototype of 5-ply CLT with 100% re-used wood produced at NTI

© Waugh Thistleton Architects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Investigation of bio-based adhesives

Adhesives are a crucial component for production of engineered wood products such as Cross Laminated Timber (CLT). However, most commercially available adhesives are fossil-based.

Given the rising demand for sustainable building materials, bio-based adhesives offer a promising solution for enhancing the sustainability of engineered wood products even further. Build-in-Wood tested both market-available and newly developed bio-based adhesives.

Promising adhesives were used to produce small-scale samples, which were evaluated for emissions to the indoor climate and for mechanical performance. Several adhesives showed promising potential, including low emissions of volatile organic compounds (VOCs) and formaldehyde, reduced greenhouse gas (GHG) emissions, and structural performance.
In summary, novel bio-based glues in CLT production offer numerous advantages, including their renewable nature, low VOC emissions, improved environmental performance, high bonding performance, and compliance with green building standards.

Bio-based glues can contribute to reduce the dependance of fossil-based chemistry in engineered wood products, supporting the shift towards carbon-neutral construction practices.

FUTURE EFFORTS

Future efforts will focus on further research and development of industrial suitable solutions (cost and speed), industry partnerships, and developing specific services to advance these innovative solutions.


Niels Morsing, Director,
Danish Technological Institute

Bio-based glues with industrial properties is an area with enormous potential for wood construction.


Purbond CLT
© Hannes Plackner

Build-in-Wood ICT Tools

"BIMification" for more data consistency in planning, production and operation

Overall, the importance of ICT tools in the building process cannot be overstated. They enhance collaboration, boost efficiency, improve decision-making, and contribute to the successful and timely delivery of construction projects. As technology continues to advance, the construction industry is likely to benefit further from the integration of innovative ICT solutions.

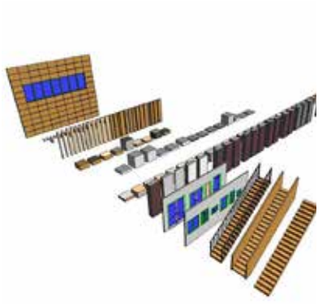
In order for Build-in-Wood to develop an efficient, adaptable, and measurable construction system, the assistance of digital communication tools and technology is needed. BIM addresses both these issues by setting up a semantic dictionary and a property structure that permits a higher rate of calculation and data gathering for a project.

Led by Bimetica, a international BIM consulting company specialized in BIM integration for product manufacturers, the Build-in-Wood ICT tools were developed to be inclusive, and adaptable for all projects and designs. The result is the BIM library, an easy-to-use collection of elements that can help with planning and specification in timber construction. With the innovations of the Build-in-Wood project partner hsbcad, the project has also achieved a major breakthrough: a new development in Revit that significantly advances multi-storey timber construction.

Through BIM, Build-in-Wood's construction system is adaptable, measurable and it is possible to communicate it through various stakeholders in order to reach efficiency goals. In addition, BIM objects have been used for visualization of digital pilot projects. The first step of on applying BIM to Build-in-Wood was to define the primary construction elements that have been used in the Build-in-Wood construction system. These construction elements in BIM comprise the Build-in-Wood BIM Library. Each BIM element is subjected to the IFC schema, which enables it to provide information directly to project data and aid in measuring and decision-making in Build-in-Wood projects.

Cristóbal Bernal, Bimetica.com

The industry is undergoing a digital transformation, with many tools available to help design and coordinate construction projects. However, not all stakeholders are able to maintain the same level of digitalization. Bimetica is focused on helping to achieve a level playing field for all stakeholders by ensuring access to coordinated information.



THE "BIM DATABASE" FOR PROFESSIONALS

The BIM database streamlines Build-in-Wood design procedures by using the Industry Foundation Classes (IFC) schema and the Guide to Developing Objects in BIM (GDO-BIM) for structured data. It organizes object categories and property sets, ensuring consistent access for stakeholders and improving collaboration, decision-making, and sustainability in wood construction.

THE "BIM LIBRARY"

The Build-in-Wood BIM Library is a vast digital repository of building components and data in standardized formats compatible with various BIM software, including Autodesk Revit and AutoCAD. Accessible for free at Bimetica.com, it features 1,230 product profiles in five languages and supports the GDO-BIM Standard, facilitating efficient and accurate design and analysis. With 438,000 views and 244,000 downloads, it stands as the largest international BIM library for wood construction, marking a significant achievement in the BIM professional community.

THE "OPEN SOURCE SPECIFICATION NODE APPLICATION"

To enhance coordination among project stakeholders, Bimetica has developed the Specification Node, an online Open-BIM platform for managing and specifying BIM projects collaboratively. Based on the IFC format, it allows users to host and share project files and documentation without needing installed software, supporting both design and construction phases as well as Digital Twin management. The Specification Node acts as a central common data environment, bridging both experienced and novice BIM users.

EXTENSION OF EXISTING PRODUCTS FOR INDUSTRY

The project has achieved a major breakthrough by establishing key anchors that significantly advance multi-story wooden construction. Various add-ons for Design for Manufacturing and Assembly (DfMA) enhance modern BIM planning. hsbcad and Rothoblaas have upgraded Revit families with specialized wooden construction elements. Rothoblaas products now use hsbcad's new Coded Family Extension (CFE), which includes automatic model updates, precise component placement, and CNC-ready wood processing (slots, cuts, drills). This enhances flexibility, simplifies CNC machine export, and showcases hsbcad's software capabilities.

Martin Dittberner
Country Manager, hsbcad

At hsbcad, our purpose is to reshape today's construction industry into a sustainable and innovative tomorrow. That's why hsbcad continually looks to break the boundaries of current technology to deliver the most efficient and flexible software solutions for Design for Manufacturing and Assembly (DfMA) in the offsite timber construction sector, the greenest segment of our industry.

Build-in-Wood BIM Library

Design Guide Digitalization

Build-in-Wood Digital Pilots

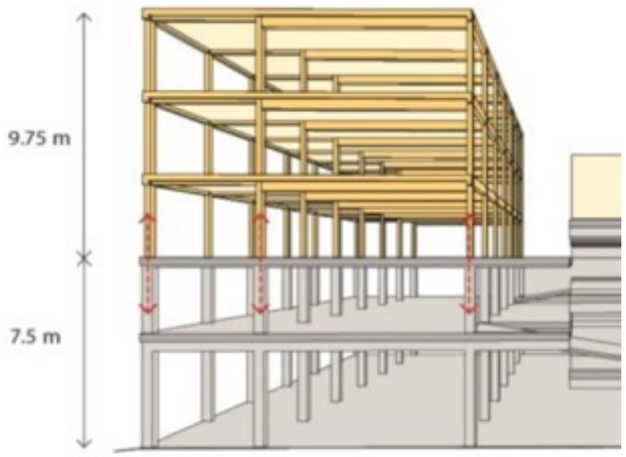
Showcasing and documenting different applications of the Build-in-Wood system

As part of the Build-in-Wood project, the consortium partners engaged with different municipalities across Europe at varying stages of understanding, and in some cases promoting, sustainable timber construction to help them on this journey.

The following example projects were the outcome of collaboration with these cities to use the Build-in-Wood system to address some of the issues most critical to each of their circumstances and are presented to help demonstrate the flexibility the system offers.

Rob Marsh,
C.F. Møller

> *The digital pilot projects demonstrate how timber buildings can decarbonize the built environment.*



Digital Pilot Amsterdam, Netherlands

TRONDHEIM, NORWAY
Using timber to retrofit existing building stock

The consortium was tasked with investigating the use of the Build-in-Wood System for retrofitting and extending a Vestilia housing association project. This project focuses on sustainable retrofit and expansion of a common typology in the district, as part of a larger study on timber construction in Norway, led by the Norwegian Technological Institute (NTI).

LONDON BOROUGH OF HARINGEY, UNITED KINGDOM
Imagining social housing proposals in timber

The London Borough of Haringey is launching a program to build high-quality council homes for social rent and develop Zero Carbon local planning policy. The study demonstrated the system's flexibility for unique layouts and aesthetics in timber. This informed the development of 'The New Model Building' by Waugh Thistleton Architects and other UK experts. The system features a mass timber structure with a fully non-combustible façade pre-assessed by a UK warranty provider.

TRENTO, ITALY
A timber transportation landmark

Trento, located between the Alps and the rest of Italy, prioritizes transportation. The municipality asked the consortium to explore a landmark tower design using the Build-in-Wood System, featuring an observation deck with mountain and city views, and an innovative bike storage solution.

Digital Pilot Innsbruck, Austria

Digital Pilot Trento, Italy

INNSBRUCK, AUSTRIA
Developing a new mountainside timber community

The municipality of Innsbruck, familiar with timber construction, sought to understand how the Build-in-Wood System could enhance sustainability and minimize carbon emissions in new developments. The response proposed a series of blocks with two main bays on the same grid, offset to increase daylight, provide circulation space, and reduce massing volumes.

AMSTERDAM, THE NETHERLANDS
Proposing new timber housing

The Metropolitan Region of Amsterdam (MRA) is promoting timber use in Dutch construction. The consortium was asked to appraise and propose designs for two housing development sites, aiming to demonstrate efficient timber construction.

Design-guide
„Build-in-Wood Examples"

Build-in-Wood Demonstrator

Realising the Build-in-Wood building system as a laboratory for further development

The Build-in-Wood Demonstrator is a showcase of the Build-in-Wood building system, allowing the consortium to demonstrate and test both the constructability and performance of the proposed solutions in a real-world context.

The product of intense collaboration and enthusiasm between consortium partners, the Build-in-Wood Demonstrator has been constructed at the Danish Technological Institute, near Copenhagen in Denmark.

The two-storey building is conceived in three parts: A conventional office space designed using a ‘pure’ representation of the Build-in-Wood system, a central connecting atrium space (the site-specific building core / stability structure) where the beauty and quality of exposed structural timber is celebrated, and finally, a construction laboratory where various iterations / solutions of wood construction materials, components and systems can be tested, compared and monitored. Initial testing will include hygrothermal performance of the building envelope, acoustic performance and monitoring of moisture in the wood structure, with the design optimised to enhance the potential for future research, development and innovation.

As a result of the project, the demonstrator was designed, planned and built.

Anders Kjellow
Danish Technological Institute

The Build-in-Wood Demonstrator leaves a physical legacy of developments and achievements in the Build-in-Wood project. With its unique and flexible design, it will be an invaluable test facility and development asset for the wood construction sector to help accelerate innovation in wood construction both now and in the future.

TARGET GROUPS OF THE DEMONSTRATOR

The Build-in-Wood Demonstrator has relevance for both the demand and the supply side of the value chain. Public and private construction clients and insurance companies can come to experience and study a wood building up close while producers, designers, and researchers can test new materials and innovative solutions in a full scale test building.

IMPACT ON INDUSTRY AND FUTURE PROJECTS

The Build-in-Wood Demonstrator is a unique test building designed for disassembly where all parts of the building such as floors, walls, ceilings, facades and their individual components and materials can be exchanged to allow for testing and documentation of new innovative biobased materials and solutions for the construction sector. The Demonstrator can be used by both future research and innovation projects e.g. future EU Horizon projects as well as industry stakeholders. The Demonstrator is open for all interested stakeholders.

Design-guide „Building System”

Build-in-Wood Design Guide

for construction of multi-storey wood buildings

The Build-in-Wood Design Guide provides essential information for the design and construction of multi-storey wood buildings. A central feature of the guide is the construction guide for the Build-in-Wood building system, but the Design Guide contains additional valuable information about the benefits of wood as a construction material, the importance of understanding the special construction process for wood buildings, the legislation and policy initiatives related to wood construction, etc.

The Design Guide targets professionals in the construction industry, particularly clients and designers, and aims to provide information and inspiration about using wood in construction to facilitate and encourage its use.

Niels Morsing, Director,
Danish Technological Institute

The creation of the Build-in-Wood Design Guide has been a fantastic team effort with contributions from almost the entire consortium. It highlights some of the key project developments and is in itself a key result of the project that provides the construction industry with an entry point for exploring the benefits and opportunities of wood construction.

The Design Guide consists of five thematic areas to dive into the world of timber construction and to benefit from well-founded knowledge and practical insights to make wood a natural choice in construction.

WHY BUILD IN WOOD

Exploration of three perspectives on building with wood: From a social perspective, timber construction offers significant social and societal benefits beyond environmental and economic realms, the environmental perspective dives into the major advantages of building with timber for the environment, and the economy perspective presents a collection of economic benefits of using wood in construction.

WOOD AS A MATERIAL

Discover why wood is a versatile and robust material suitable for various construction needs. This section covers essential properties and behavior of wood as a material and gives an overview of the main wood based construction products and their typical application. The main types of prefabricated wood elements as well as their application and advantages are also discussed.

THE BUILD-IN-WOOD SYSTEM – AND OTHER APPROACHES TO BUILDING IN TIMBER

This section provides a guide to the Build-in-Wood system including the load bearing structural system and the façade elements. It also gives an overview of other commonly used timber construction systems and their typical application. Digital pilot projects from European cities showcasing versatility of the Build-in-Wood system is also presented.

DETAILS ABOUT THE BUILDING PROCESS

Gain insights into the streamlined processes that make timber construction efficient and sustainable. Learn about the advantages of prefabrication, digitalization aspects, and the importance of logistics and moisture management when constructing with wood.

REGULATIONS

Get an overview of regulations, strategies, initiatives and action plans related to wood construction within the EU. Explore current timber policies and learn how cities and regions can prioritize wood to create a more sustainable built environment. Learn about the requirements of individual EU member state building codes and regulations for the use of wood in construction e.g. within fire safety, acoustics and other aspects.

BUILD IN WOOD
DESIGN GUIDE

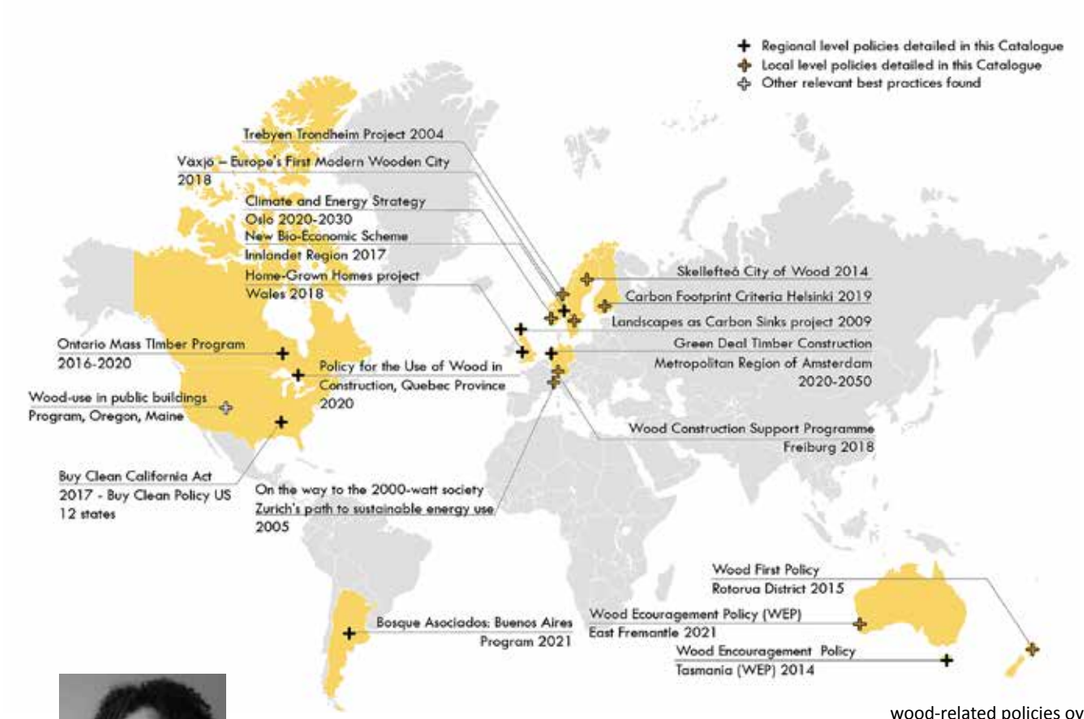
design-guide.build-in-wood.eu

Build-in-Wood Policy Catalogue

The policy catalogue outlines the rationale, characteristics, and impact of various policies around the globe at national and sub-national levels, providing insights into the different typologies of instruments deployed, their strengths and weaknesses. It aimed to support cities and regions in channeling their efforts to create a more sustainable built environment by prioritizing wood either implicitly or explicitly.

Through Build-in-Wood, URBASOFIA addresses the challenge of translating novel wood building systems, pilots, wood value chains for the construction of multi-storey wood buildings, and promising practices into policy.

This was achieved by working on understanding the real needs of cities and territories, the drivers, and the key entry points and preconditions for new policies supporting multi-storey wood buildings and genuine carbon-neutrality. Specifically, the findings of the Build-in-Wood Policy Catalogue are based on the close collaboration with seven affiliated cities (Early Adopter Cities in Europe), outlining and integrating the results of (a) Multi-criterial urban planning, strategic and regulatory context analysis, (b) Participatory and co-design approaches implemented with their local stakeholder ecosystem from the wood construction value chains and (c) Research of different best practice policies at national, regional and local level from different parts of the globe that incentivises the building in wood through informative, financial, research and regulatory instruments.



Madalina Rusen, Urbasofia

> *Timber-related policies should transcend mere material choices, reshaping economies and challenging urban planning norms. Their alignment with contextual prerequisites and relevant cross-sectoral policy subsystems is pivotal in strategically lowering carbon emissions, enhancing affordable housing and resilience, and propelling circular economies forward.*

process of working with Early Adopter Cities within the Build-in-Wood project, as well as the main findings. This chapter includes the conclusions of multi-criterial urban planning and strategic and regulatory framework analysis in each EAC, together with the main findings from the participatory and co-design approaches implemented with their local stakeholder ecosystem.

> It includes a series of transferable lessons learned from different geographical parts of the globe and recommendations and criteria for municipalities to support and guide the adoption of pro-wood policies and achieve their sustainable built environment agendas.

RELEVANT TARGET GROUPS

> Municipalities across Europe, supporting them in achieving their Net Zero Carbon 2050 ambitions and define specific pathways for lowering embodied carbon by prioritizing wood;
> Policymakers working on the formulation and definition of wood-related policies, built environment policies or other relevant policy and strategy subsystems (e.g forestry sector, bioeconomy, circularity);
> Other decision-makers and administrative bodies.

KEY BENEFITS OF THE CATALOGUE

> It provides in-depth understanding of how different cities, regions and countries implemented wood-related policies over the years or plan to implement them in the future.
> It represents a valuable resource for supporting methodological transfer and replication of the findings to wider range of EU cities and beyond.

WHAT TO EXPECT FROM THE POLICY CATALOGUE?

> It offers an overview of current best practices and new developments in the policy and regulatory environment governing the construction sector, specifically in relation to building materials and the use of wood in multi-storey buildings. Several best practice policies from around the globe are mapped and detailed (national, regional and local levels).
> It explains the methodology and

Build-in-Wood Design guide:
"Timber policies in cities and regions", incl. download of "Build-in-Wood Policy Catalogue"

Build-in-Wood Community:
"Network group for cities and municipalities - Build-in-Wood Replication Cluster"

Evaluating Multi-Storey Wood Buildings

The objective of our research was to conduct comprehensive post-occupancy evaluations of existing multi-storey wood buildings, focusing on both their technical performance and the perceptions of their users. This study aims to gather, document, and disseminate valuable performance data and user feedback, providing insights that will enhance the design and functionality of future multi-storey wood buildings.

The study encompasses two main components: assessing the technical performance of the buildings and exploring the perceptions and experiences of the occupants. This dual approach is crucial for ensuring building quality and addressing any issues related to the building's construction or its use. The results will not only inform the planning and construction of new buildings but also improve the utilization of existing structures. Moreover, this research promotes an evidence-based, performance-oriented approach to building design.

Henriikka Taipale,
Danish Technological Institute

> *The occupants across the case study buildings appreciate the aesthetics of wood and associate it with positive impressions, feelings and sensations. Many prefer visible wood surfaces indoors, but in combination with traditional painted walls and ceilings, because the materials affect how occupants use the surfaces. Exposed wood increases the aesthetic value of homes as they are seen as beautiful in and of themselves.*

FACTS:
Case studies wood buildings:
5 in Denmark and Norway
Participating occupants:
76 in survey
16 in interviews
8 in long-term indoor climate measurements

WHY CONDUCT THIS ANALYSIS?

Evaluating both the technical and user perspectives is essential for several reasons. It helps identify and resolve any issues, ensuring the overall quality and efficiency of the buildings. The data collected provides a foundation for informed decision-making in the planning of new projects, enhancing the design and use of wood buildings. This approach supports the development of buildings that meet high standards of performance and user satisfaction.

AREAS OF INVESTIGATION

The study investigates various aspects of the buildings:

- **ACOUSTIC PERFORMANCE:** based on technical data, such as on-site measurements, combined with questions on acoustic performance.
- **INDOOR CLIMATE AND EMISSIONS:** based on building performance simulations and technical data, such as on-site measurements, combined with questions on indoor environment.
- **FIRE SAFETY:** based on questions about fire precautions and what occupants think about them and about fire risk in general.
- **SUSTAINABILITY:** based on the technical data available, such as building certification documentation, combined with questions about sustainable materials.
- **AESTHETIC AND SENSORY EXPERIENCES:** based on questions, the user perceptions of aesthetic and sensory experiences have been assessed.
- **OVERALL BUILDING PERFORMANCE:** based on questions, the user perceptions of the building as a whole show interesting and relevant perspectives.

Some of these topics are more suited to quantifiable, technical evaluations, while others benefit from qualitative assessments of user experiences. By combining these approaches, our study provides a holistic understanding of the performance and user satisfaction of multi-storey wood buildings, paving the way for improvements in future designs.

Wood Academy Talk:
"Living in a wood building - a Danish case study"
January 2022
www.build-in-wood.eu

Sustainability Assessment of Build-in-Wood solutions

Timber buildings are receiving attention for their ability to transform the building and construction sector from carbon emitter to net carbon sink and for their potential to reduce material consumption through cascading processes (i.e. multiple reuses). The Life Cycle Approach was implemented to assess the sustainability of the proposed solutions by the Build-in-Wood project.

Build-in-Wood project aligns with the UN 2030 Agenda by contributing to address some of the world's most pressing social, environmental, and economic challenges by providing concrete solutions.

The Build-in-Wood project has conducted a comprehensive Life Cycle Assessment (LCA) to evaluate the potential environmental impacts of its proposed timber construction solutions. This assessment spans the element, component, and building levels. By calculating average potential impact results and integrating them into the Building Information Modeling (BIM) environment, the project aims to facilitate future designs that consider both environmental impacts and technical feasibility.
Two primary issues have been identified in strict ISO standard-compliant assessments: the end-of-life of timber buildings and their expected lifespan. The project has proposed and tested various approaches to address these flaws, enhancing the robustness of its sustainability assessments.

Simone Bastianoni
University of Siena

> *The sustainability assessment regardless of the precautionary hypothesis has shown that building in wood is a much more sustainable alternative. It is important though that a full value-chain of engineered wood is implemented that that forsees mutliple, cascading re-uses and ensures a lifespan that overcomes the forest turnover time.*

CONTRIBUTION TO THE UN SUSTAINABLE DEVELOPMENT GOALS (SDGS)

The Build-in-Wood project aligns with the 2030 UN Agenda, contributing to the achievement of the Sustainable Development Goals (SDGs). The project's report outlines how its solutions can support these goals, providing specific targets and possible indicators for impact quantification.

LIFE CYCLE THINKING AND SUSTAINABILITY

Life Cycle Thinking assessments are crucial in identifying areas for improvement and providing a snapshot of the current sustainability level of products and processes. Within Build-in-Wood, Social Life Cycle Assessment (S-LCA) has been implemented, marking one of the first applications of S-LCA in the timber construction sector. This framework assesses the social dimension of timber buildings, offering valuable insights for stakeholders.

ECONOMIC ASSESSMENTS: LCC AND CBA

The project also employs Life Cycle Costing (LCC) and Cost-Benefit Analysis (CBA) to estimate the total costs of timber and concrete buildings throughout their entire life cycle. These assessments consider costs from conception and design to production, use, and disposal. The main objective is to determine the true cost of ownership and associated benefits such as energy efficiency, reduced downtime, and increased productivity. The results, particularly relevant for designers and builders, have so far focused on potential investments in Italy and Greece for commercial and residential buildings.

Through its innovative approaches and comprehensive assessments, the Build-in-Wood project is paving the way for more sustainable and economically viable timber construction, supporting global efforts to achieve a more sustainable future.

Build-in-Wood Community

As a key result of Build-in-Wood, the globally accessible Build-in-Wood Community has been established as a new way of networking, knowledge sharing and exchanging experiences for everyone working with wood in the architecture, engineering and construction industry.

Our Vision:
Envisioning a world where building with wood is a natural choice, the Build-in-Wood Community is the most valuable global online network to bring people along the whole construction value chain closer together.

Our Mission:
Bringing people together in a global online network where members can share knowledge and experiences, inspire and be inspired, expand their professional network and exchange ideas, develop their business as well as find new project partners – in a network with an independent and non-profit business model.

Anders Kjellow
Danish Technological Institute

The Build-in-Wood consortium are proud to have established the Build-in-Wood community as a key collaboration platform for the wood construction industry and to have secured it's successful continuation beyond the lifetime of the Build-in-Wood project.

WHAT'S THE COMMUNITY ABOUT?

The Community was established to provide the wood construction industry with a collaboration platform to contribute to innovation and address barriers for wood construction. Community members can help each other to reach their goals by sharing knowledge, learning from each other, talking together about barriers and how they have solved the challenges they have faced, but of course also share success stories and good experiences. Therefore, the Build-in-Wood Community is all about connection, sharing and exchange to:

- connect with professionals in a global network
- join groups about topics members are interested in
- interact with other members of the Community

WHY SHOULD PEOPLE JOIN?

Networking and knowledge transfer are vital to development and innovation, breaking down barriers, and business growth. Members can find like-minded professionals to share their thoughts with, be inspired by and learn from to establish their own wood construction network. The Community is a free of charge platform!

WHO CAN BENEFIT FROM THE BUILD-IN-WOOD COMMUNITY?

- Architects
- Developers
- Knowledge institutions
- Engineers
- Producers
- Authorities
- And many others

IMPACT:

- **Enhanced collaboration** among professionals can lead to innovation, improved solutions and more efficient construction processes.
- **Knowledge sharing** will help professionals stay updated on the latest trends, technologies, and techniques in wood construction, ultimately leading to higher quality projects.
- **Skill development** can be particularly beneficial for professionals looking to specialize in wood construction or those seeking to incorporate sustainable and innovative wood design practices into their projects.
- **Market expansion** to open up opportunities for business growth and diversification.
- **Advocacy and awareness** for the use of wood in construction to?
- **Research and development** initiatives aimed at advancing the use of wood in construction. This may include exploring new materials, construction methods, and building technologies that leverage the unique properties of wood.

BUILD IN WOOD Community

community.build-in-wood.eu

Facts & Figures

Highlights of Build-in-Wood Communication, Dissemination, Exploitation

Wolfram Allinger-Csollich
rtd services

Simon Holzknecht
proholz Tirol

Continuous and targeted communication with the relevant stakeholders was a key success factor, both for achieving the project results and for disseminating them.

14 Press releases

> 200 Press articles

7 Early Adopter Cities

60 Blogposts

12 Newsletter

> 20.000 Followers on Social Media

17 EAC Workshops

1:1 Build-in-Wood Demonstrator building

7 Digital pilot projects

BUILD IN WOOD Community

About **2.000** Members from more than **50** countries.

3 Scientific publications

2 in preparation

BUILD IN WOOD DESIGN GUIDE

Design Guide

2 pending patents for new connection systems

3 Building-System-Booklets

Policy catalogue

25 Wood Academy Talks with about **1.000** participants

15 Key Exploitable Results

IMPRINT
We thank all project beneficiaries of Build-in-Wood for their contributions to this Exploitation Booklet to present the main project results to a wider audience.

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Ethical Issues:
The Build-in-Wood consortium undertakes to respect all basic ethical principles as outlined in the Charter of European Fundamental rights, including dignity, cultural, religious and linguistic diversity, equality and anti-discrimination, freedom of expression and of information and respect for the environment.

Additional Information:
Website: www.build-in-wood.eu
If you like to get in contact with one of our Build-in-Wood experts and partners, please, feel free to contact:
Project Coordination: Mr. Anders Kjellow, DTI, Denmark (email: awk@teknologisk.dk)
Exploitation Manager: Mr. Wolfram Allinger-Csollich, rtd services, Austria (email: allinger@rtd-services.com)

These two contact persons will target and guide you to the right person to talk to.

BUILD IN WOOD

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