

WOOD IN
CONSTRUCTION
25 CASES
OF **NORDIC**
GOOD PRACTICE

Wood in Construction

25 cases of Nordic Good Practice

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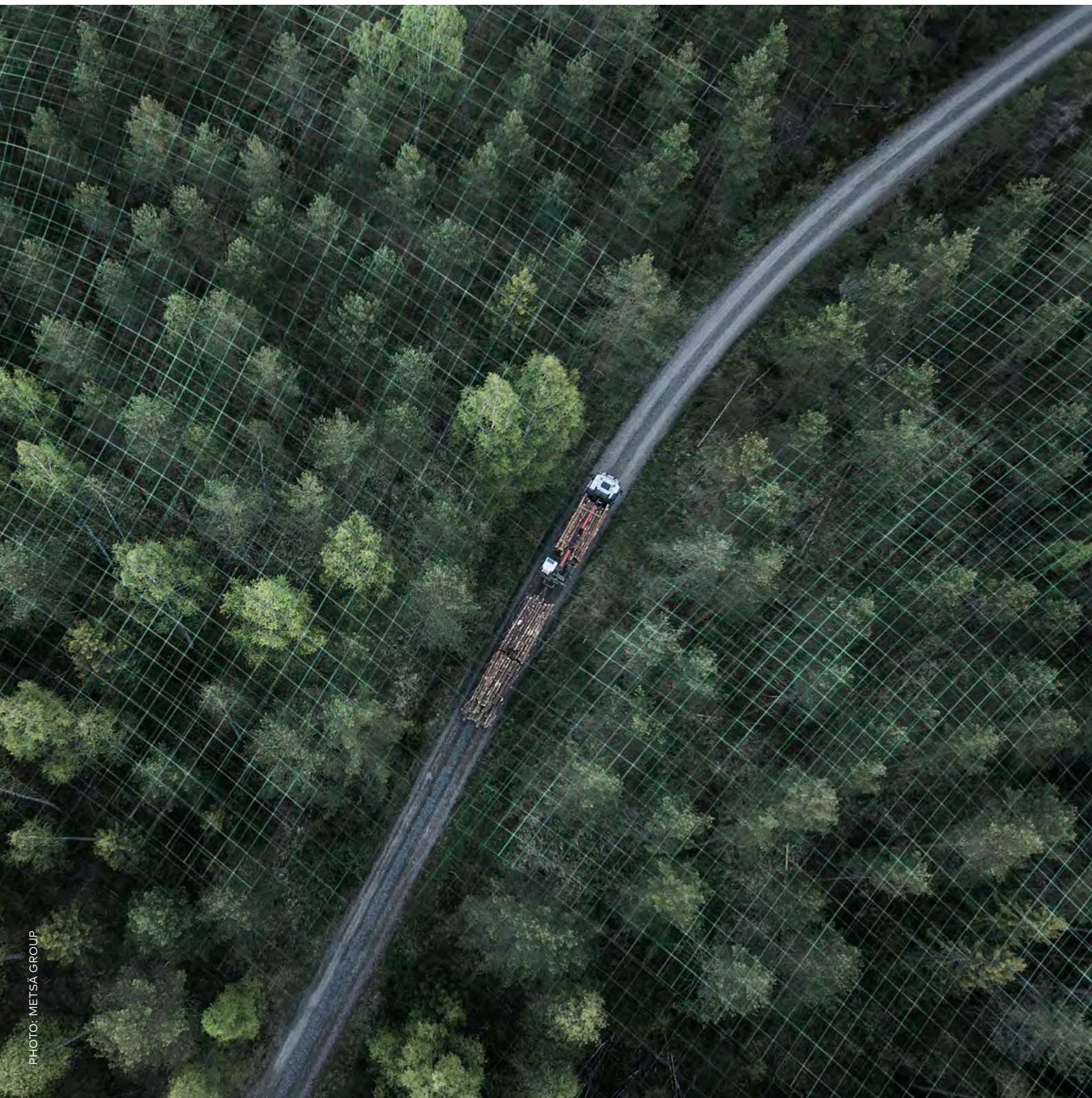


PHOTO: METSÄ GROUP

Why wood is the future of construction

Every day, the need for immediate and substantial action to tackle climate change becomes ever more apparent. Combined with this challenge is a growing and increasingly urbanised population – in the Nordics, as in much of the rest of the world – creating a rising demand for housing, schools, hospitals and offices, and putting strain on rural economies.

The construction industry uses vast amounts of finite resources, and is responsible for around one third of all carbon emissions globally. By 2030, total construction output is expected to grow by 85%, and as our appetite for constructing new buildings expands, it compounds the climate and resource scarcity problems that we face. Significant efforts have been made to improve the energy efficiency of our buildings, but the sector hasn't made much headway in reducing carbon emissions from the materials that we build with.

Using wood as a building material has the potential to change that, reducing the carbon footprint of our buildings by using the only renewable construction material. This is especially true in the Nordics where we are surrounded by an abundance of sustainably managed forest resources, and have a long tradition of building with timber. From a climate perspective, wooden construction is a no-brainer, but further use of timber also delivers financial, social and health co-benefits that are currently under appreciated, drives innovation and boosts the Nordic bioeconomy in rural communities.

The 25 cases of good practice presented in the following pages demonstrate the innovative ways in which the Nordic countries are pushing the boundaries of what is possible through the timber construction value chain: cutting-edge climate smart forestry feeding into innovative design processes to build beautiful, healthy and sustainable buildings faster than ever before. These 25 cases demonstrate that the Nordics have the resources, experience and the will to build sustainably with wood.

The team behind this report, the Nordic Wood in Construction Secretariat, is an initiative commissioned by the Nordic Council of Ministers and the Swedish Government, and hosted by EIT Climate-KIC, with an aim to support and accelerate the use of wood in construction in the Nordics. They do this by improving regional dialogue, knowledge-sharing and collaboration on wood in construction, and sharing Nordic solutions with the world.

I hope you'll find this report an inspiring and useful reference piece, and a conversation starter on how to use wood for the good of future construction.

Mads Randbøll Wolff

Chairman of the Nordic Wood in Construction Secretariat



PHOTO: UNSPLASH

Introduction

Nordic forestry innovation has huge potential to cascade the use of wood into high-value products that bring multiple co-benefits. In the construction sector, it is clear that when paired with sustainable forest management, there is a potential for wood to act as a carbon sink when used as a construction material. However, other environmental, economic and social co-benefits are currently under-recognised, and as such, wood's full potential throughout the construction value chain is yet to be realised.

This publication, by the Nordic Wood in Construction Secretariat, showcases 25 examples of Nordic projects from throughout the value chain working with wood in exciting and innovative ways. The aim is to demonstrate the benefits and drivers for building with wood, providing inspiration for the next generation of wood construction projects.

BENEFITS OF BUILDING WITH WOOD

GREEN

Wooden construction uses a renewable material that embeds carbon in the structure, offering a more environmentally friendly alternative to concrete or steel.

FAST

Timber gives greater structural integrity with less weight and is often prefabricated for buildings, saving time and money in transport and construction.

HEALTHY

Building with a natural material has proven health benefits and contributes to an improved indoor climate thanks to its moisture absorbing properties.

25 cases of Nordic good practice

Concerns over wood construction regarding fire, moisture and acoustics are often used as an argument for not using wood, however the 25 cases presented here, and the numerous other wood construction projects in the Nordics and elsewhere are actual proof that it is possible to deal with these concerns. However, greater knowledge and understanding of new and innovative ways of working with wood in construction is required amongst stakeholders across the value chain. To take advantage of wood's potential, these stakeholders must come together behind bold commercial and environmental commitments, but currently lack the incentives to do so.

To reach the final 25 cases presented here, an open call outreach campaign was held where projects were nominated and applications submitted to be included in the publication. These applications were scored against the five assessment criteria shown here, which had been developed through workshops and interviews with sector experts. The highest scoring cases, accounting for a geographical and value chain spread, are presented here. You can read more about the methodology on page 74.

INNOVATION

Use of technology, business model innovation, and spreading benefits across the value chain



ENVIRONMENTAL BENEFITS

Climate change mitigation, circular principles integration, and addressing biodiversity issues



SOCIAL & LOCAL BENEFITS

Local economic value generation, health and livability benefits, and building competence in the local community



ECONOMIC BENEFITS

Potential to save costs and time across the value chain, and scale into new markets



PARTNERSHIPS

Engaging cross-sector and partnering across the value chain while operating in a transparent manner



Some useful acronyms:

CLT – Cross-laminated timber

GHG – Greenhouse gas

CO₂ eq – Carbon dioxide equivalent

The 25 cases are broken down according to their place in the value chain as follows:

 **Chapter 1**
Forestry and Production

Chapter one showcases solutions in the early part of the wood in construction value chain. The sustainability of wood in construction hangs on good forestry practices, which are becoming increasingly digital and climate smart. As the sector is shifting so quickly, it is opening up opportunities for producers to design wooden elements in new and innovative ways.

 **Chapter 2**
Public buildings

The buildings presented in chapter two are for use by the public at large; schools, libraries, churches and cultural centres. Much of the funding for these projects comes from public funds, often at a municipality level, where local strategies are proving powerful in driving the construction of sustainable wooden buildings.

 **Chapter 3**
Private buildings

Chapter three covers a broad range of private wooden buildings, from housing developments and office spaces to farms. The projects showcased here demonstrate the constant boundary pushing in the sector, with many examples of how building in wood can provide not only environmental, but also social, local and economic benefits.

 **Chapter 4**
Second-life Wood

At the end of their lives, wooden buildings aren't simply smashed down with a wrecking ball, but are increasingly being designed for careful disassembly so that the wooden elements can be reused and recycled. Chapter four features two companies who are making use of these resources to give wood from construction a valuable second life.

5 Trends from 25 Cases

In the process of scoring and selecting the 25 cases presented in this publication, several common denominators have materialised. Based on these and the insights gained from structuring our thinking around the five selection criteria, we have been able to identify trends within the rapidly developing field of wooden construction. We believe that these trends help to define more clearly what good practice within wood in construction looks like.



1 Multifunctionality

One aspect of many of the projects that stands out is the emphasis on flexibility. In buildings this means **multifunctionality** of use such as in *Oodi* (pg. 34), and the **ability to change and adapt** spaces in the future as demands on the building change, as demonstrated in *BRF iValla* (pg. 60). This increases the longevity of the buildings, improving the economic case and reducing environmental impacts of wooden constructions.

Even in forestry and production, we see this trend continuing with the production of easily replaceable wooden elements, such as *Wave-layered timber* (pg. 26), and forestry practices like at *Metsä Group* (pg. 18) that match user needs exactly to timber felling.



2 Saving time and costs

Many of the projects in this publication utilise one of timber's major benefits: it's ability to **reduce construction times and costs**. Pre-fabrication of modular elements off-site can optimise the construction process and create more bespoke buildings matched to users' needs, as in *Östra Sala Backe* (pg. 44), and permits work to take place year-round in more extreme climates like *Skellefteå Kulturhus* (pg. 38)

Projects that focus on local supply chains such as *Mjøstårnet* (pg. 64), are able to build even faster and reduce emissions from transport of materials, with added benefits of boosting jobs and expertise in the local economy.

3 Investing in scalability

Cost is often seen as a barrier for building with wood, as changing long-established practices requires new technologies and ways of working. However, as several of the developers behind these 25 projects show, such as *Strandparken* (pg. 58), **investing in timber construction and scaling up over time gives them the skills and expertise** to lead in a more sustainable construction sector in the future.

Municipalities are also coming through to use public procurement as a driver for positive change, with timber construction playing into their climate strategies, as demonstrated by *Lade School* (pg. 40) and *Herrestaskolan* (pg. 36).



4 Pushing the boundaries

Many projects showcased here became the tallest or the largest timber project of their type on completion, and the Nordics are constantly **challenging the possibilities of building in wood**. *Mjøstårnet* (pg. 64) is set to become the world's tallest timber tower, but we are certain that they won't hold the record for long, given the pace of change demonstrated in this publication.

The diversity of projects presented here, from *Knarvik Community Church* (pg. 42) to *Flatey Farm* (pg. 52), demonstrates the adaptability of wood as a building material, allowing it to be used in almost any context.



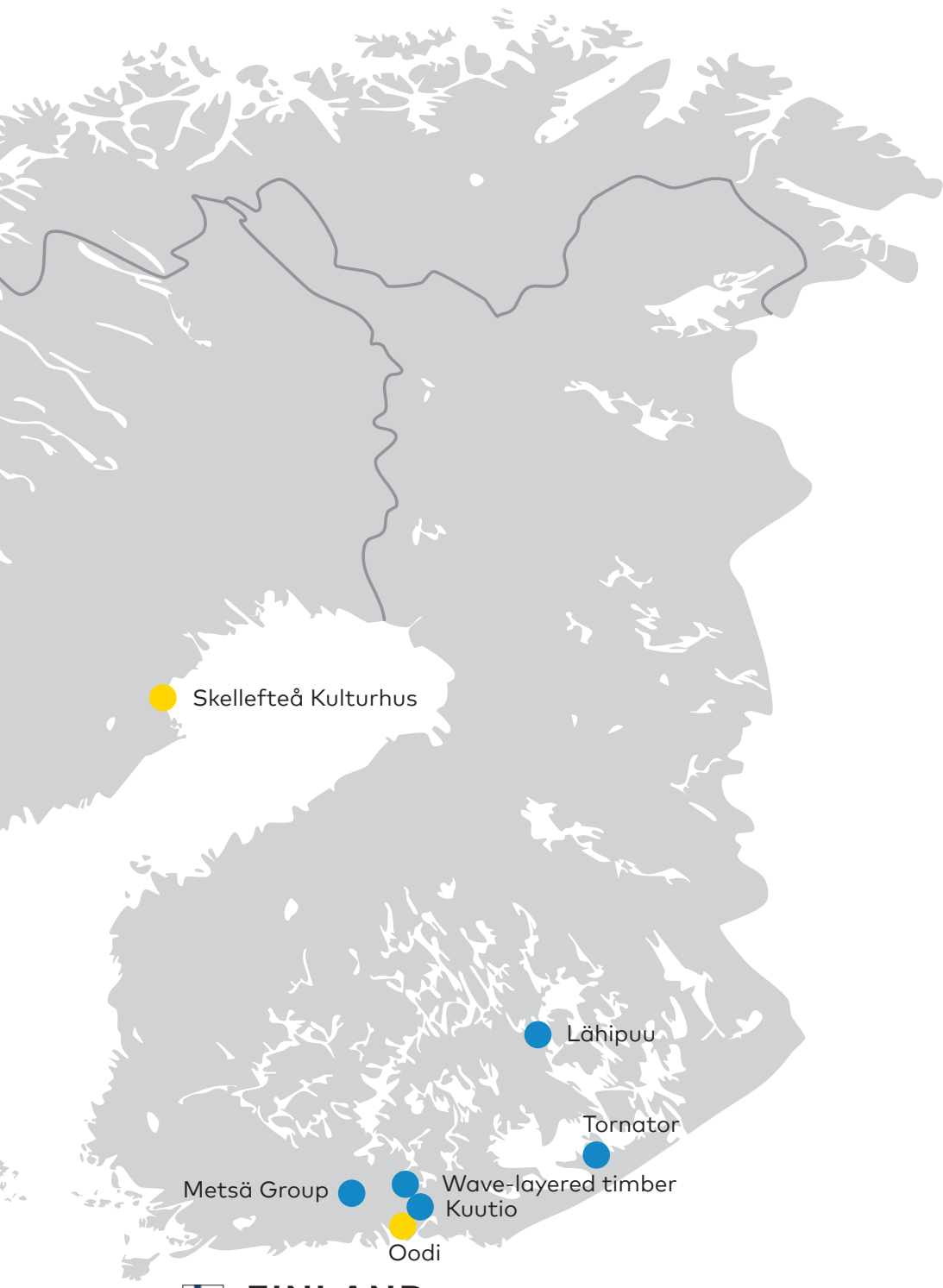
5 Circular design

Increasingly, designers are beginning to think about what happens to the building at the end of its life. In *Lisbjerg Bakke* (pg. 48), building components have been designed to be disassembled, which will **keep wooden elements higher in the value chain in their second life**. Producers are rising to the challenge, too, with products such as *Korkbyg* (pg. 30), coming to market to provide circular alternatives to traditional building materials.

This leads new opportunities for companies like *TrÆls* (pg. 70) and *Saga Wood* (pg. 72) to transform wooden 'waste' from the construction industry into new products and services.







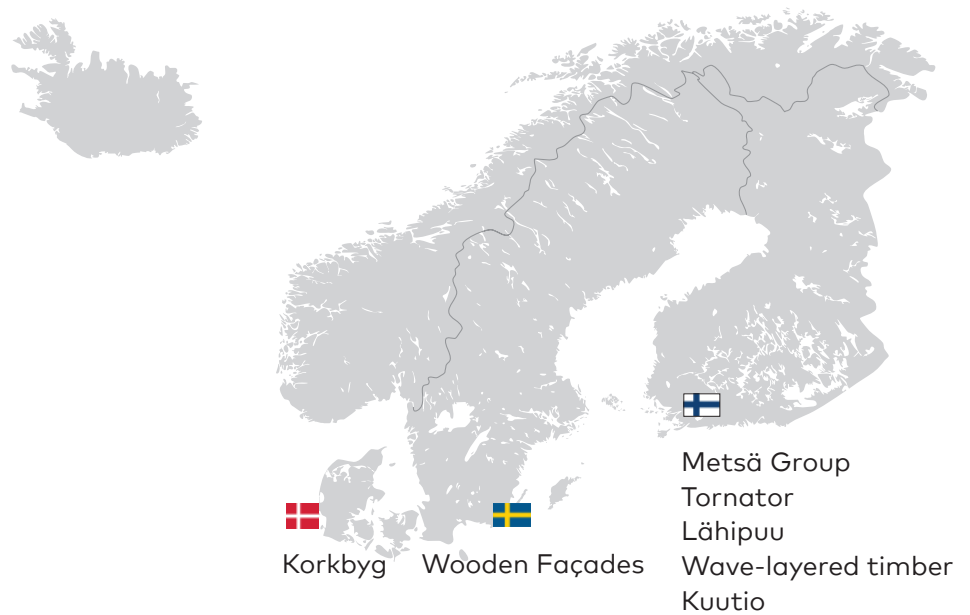
 **FINLAND**

WOOD IN CONSTRUCTION 25 CASES OF NORDIC GOOD PRACTICE

Forestry and Production

Chapter 1

Forestry and Production



Chapter one showcases solutions in the early part of the wood in construction value chain. The sustainability of wood in construction hangs on good forestry practices, which are becoming increasingly digital and climate smart. As the sector is shifting so quickly, it is opening up opportunities for producers to design wooden elements in new and innovative ways.

METSÄ GROUP

 Finland



Digital forestry revolution helps to see the wood from the trees

Metsä Group is using new technology to gather and utilise an unprecedented amount of forest data to drive intelligent felling and planting practices, that leads to improved efficiency up the 100% traceable supply chain.

Digital technology was once seen as a threat to the forestry sector, but now its integration into daily forest practices is helping to cut costs and enable smarter, more responsibly forestry. Metsä Group in Finland, with 104,000 forest-owning members, is at the forefront of a digital revolution in forestry. As **each tree becomes a data point, through remote mapping that uses satellites, lasers and drones**, it is possible to know far more about the forest than ever before. But data alone is only the start, and Metsä is increasingly incorporating it into tools that are useful to forest owners and managers as well as wood processors and buyers.

Utilising this new data through applicable tools brings new level of precision to felling and planting of trees, matching supply to demand further up the supply chain. This is made possible through a 100% traceable process, where tagging allows all wood in Metsä's supply chain to be **traced from forest through the sawmill and processing plants to end products**. Digitalisation also helps to protect forest ecosystems, with more information at hand for forest managers about forest health and when it's necessary to visit and fell sites. Transportation can also be optimised to meet felling patterns, which reduces emissions from operations and saves costs for all involved.

ECONOMIC



As digital tools vastly improve efficiency of forestry work, it is estimated that 10% of operating costs can be reduced – savings that can bring down the cost of wooden construction materials in the future.

ENVIRONMENT



The integration of useful data into forest regeneration projects means that felled areas can be replanted in the most effective ways, speeding up new forests' growth and increasing carbon sequestration.

SOCIAL & LOCAL



One in seven Finns own some forest, and new digital and virtual tools are enabling them to manage their resource more efficiently, and even to visit their forests virtually from their own home.

TORNATOR

 Finland



PHOTO: UNSPLASH

Climate smart forestry improves carbon capacity and resource efficiency

As Finland's third largest landowner, Tornator are utilising climate smart forestry techniques to ensure that increasing demand on the sector still allows the carbon stocks of their forests continue to grow.

The environmental legitimacy of using wood in construction is reliant on a thriving and sustainable forestry sector, and Tornator in Finland are demonstrating how to put environmental responsibility at the heart of their forestry strategy. The firm is the third largest landowner in Finland, managing more than 674,000 hectares of forest and has made the unusual step of becoming double certified as PEFC and FSC compliant. Tornator has sought to minimise emissions throughout its supply chain, which amount to **just 0.05% of their forests carbon sequestration capacity**. Additionally, a leadership training programme has been introduced to ensure that the values of environmental responsibility are engrained throughout the organisation.

Climate smart forestry is a first priority in Tornator's long term strategy, utilising resources sustainably, increasing carbon sequestration and protecting precious habitats and biodiversity. To ensure the longevity of their forests, annual growth exceeds felling, meaning that each year the forests are growing by 5.5m³ per hectare. A growing forest stock combined with silviculture and forest fertilisation methods result in **healthy forests with increasing carbon storage capacity**. Tornator's lands are also home to a great amount of wildlife, which is rigorously monitored and safeguarded, with hundreds of acres set aside each year for conservation.

ENVIRONMENT



Tornator's forests capture 3.9 million tonnes of CO₂ from the atmosphere each year, equivalent to about 10% of all the emissions from Finland's energy sector.

SOCIAL & LOCAL



The firm creates a 900 person-years of employment opportunities in rural areas, both directly and through its supply chains, and works in collaboration with local communities to improve recreational access to forest lands.

ECONOMIC

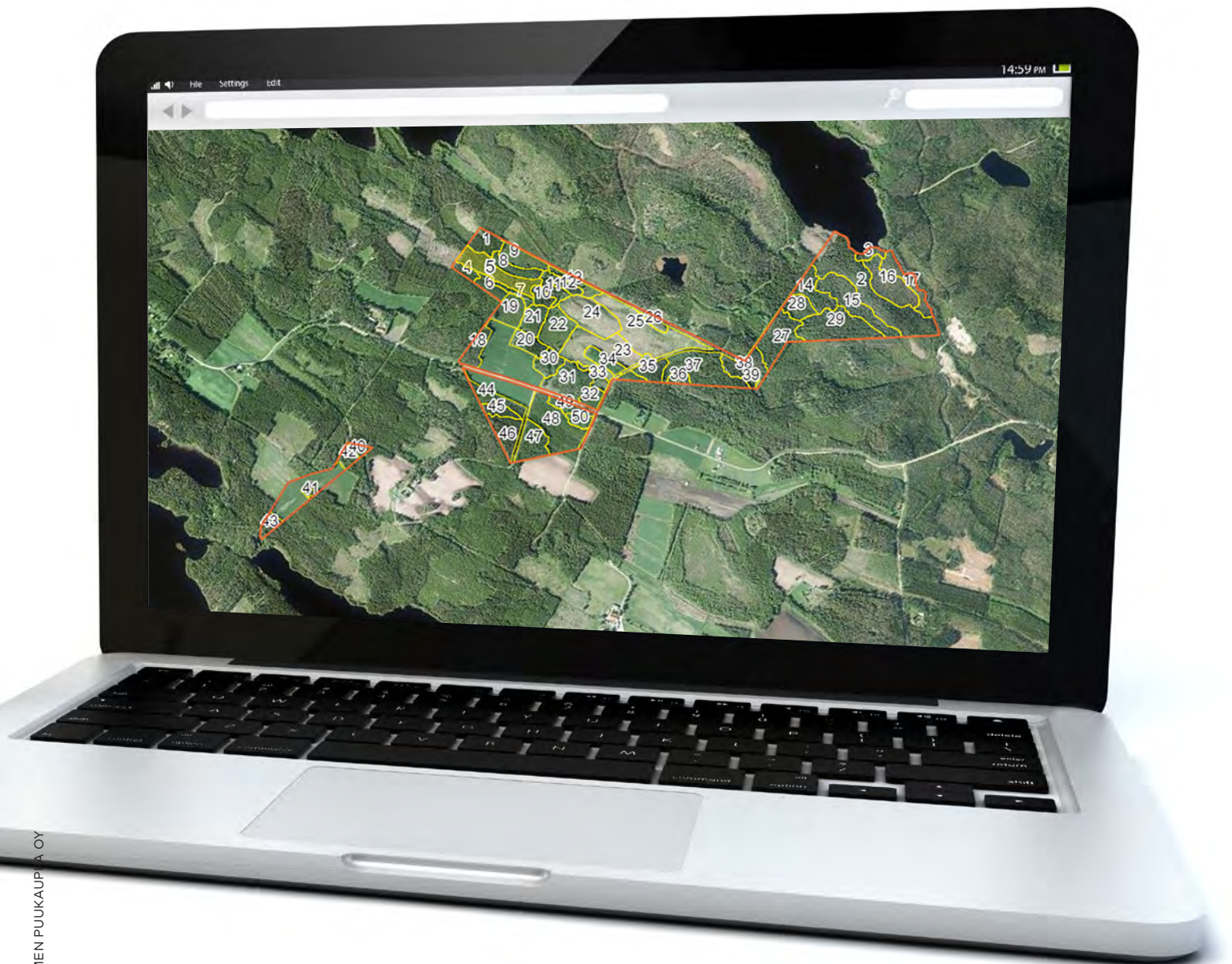


In addition to upholding high environmental standards and paying steady dividends to its shareholders, Tornator is committed to retaining net value in local economies, which it did by €14.9 million in 2017.

KUUTIO

 **Finland**

Suomen Puukauppa Oy



Timber trade revolutionised with new digital platform

Kuutio is the world's first publicly open digital marketplace for timber trade, linking forest owners and wood buyers, which traded over €500 million of wood in its first year and a half of operation.

In Finland, there are over 600,000 private forest owners, from large established land managers to new and inexperienced small owners. Bringing them together with buyers and timber professionals is Kuutio: the world's first digital marketplace for trading timber trade that is open to all. The platform was set up to benefit all stakeholders in the forestry industry through a dive into the digital world. For buyers like sawmills, Kuutio can give them access to new and bespoke supply options and improve their operations' efficiency. For forest owners, the platform is free to use and gives them easy access to the market and connections to forestry professionals who can help them in timber trade and other services. This is **especially useful for new and inexperienced forest owners** – who make up 40% of the platform's sellers.

In the first year and a half of operation, Kuutio had enabled 20,000 forest users to trade more than 13 million cubic meters of wood worth over €500 million. The platform is optimising the supply chain for wood in construction, as demand from the buyers can be met more precisely with supply of bespoke to-measure-timber, reducing waste in the sector. As well as private owners, Kuutio is also used by forestry management associations who conduct timber trade on behalf of their members. As the platform grows, the developers are **listening to the needs of the users, and constantly updating features** and adding new services to match demand.

PARTNERSHIPS



Kuutio uses digital technology to link buyers and sellers of wood more closely to optimise their operations, and ownership of the platform is split 50:50 between buyers and sellers.

INNOVATION



The platform uses national data on forest resources to improve the effectiveness of the sector, helping both buyers and sellers to reap the benefits of the digital revolution.

ECONOMIC



Kuutio gives smaller and inexperienced forest owners access to huge new markets, and in the first year and a half of operation was responsible for more than €500 million of wood trade.

LÄHIPUU

 **Finland**
Suomen Sahayrittäjät ry



Certifying local wood products from small, environmentally friendly producers

Lähipuu is a new certification in Finland that signifies 100% Finnish products from small, local producers who put environmental concerns first, helping these firms to stand out from the crowd.

Certification helps us to trust that wooden products are sourced responsibly, and FSC and PEFC are familiar names in the industry. These big international certifications are useful, but they don't help to indicate where the wood has originated from, which is important when trying to source local wood and support a domestic forestry sector. Lähipuu is Finland's answer to this, established by the Finnish Sawmill Entrepreneurs' Association. The certification is used to signify **100% Finnish products produced in using low-carbon processes by small, local businesses**. This way, Lähipuu certified products can stand out from the rest of the market.

Shipping timber by just 100km can result in carbon emissions equal to those from all of the forestry and milling processes, so how far the wood has come to be on the construction site can make a big difference to the total carbon emissions. As such, certifications such as Lähipuu that indicate **locally produced wood are a simple and effective tool to reduce emissions from transport**. In addition, these certified products are made to the highest environmental standards, so buyers can be sure that they are making a choice for low-carbon wooden construction materials that come from healthy forests.

ECONOMIC



Lähipuu supports local wood producers by helping them to stand out from the crowd with a distinct mark of environmentally friendly, local, small businesses that serve their communities.

ENVIRONMENT



This certification is designed as a signal to buyers that the product has low associated carbon emissions, and is produced to high environmental standards, something that is increasingly in demand in the market.

SOCIAL & LOCAL



Small businesses are the lifeblood of rural economies, and Lähipuu helps to steer buyers towards products that support jobs and prosperity in local economies.

WAVE-LAYERED TIMBER

 **Finland**
Aalto Haitek



Wave-layered timber makes a splash in Finland's wooden construction sector

Glue-free wave-layered timber is a major innovation that reduces costs of building with wood through a focus on simplicity and flexibility.

Many wooden construction materials rely on adhesives to keep them together, but a new system designed by Aalto Haitek in Finland is out to change that. Wave-layered timber (WLT) is a glue-free building system that utilises the strength of the wave shape to lock together self-tightening components. The system has flexibility and simplicity at its heart, and creates extremely strong structures that can be **built rapidly without the need for adhesives, nails, chemicals or toxins**, opening new opportunities for architects to flex their creative muscles with wood in construction. The goal is to scale the technology to a global market, with licencing soon available.

A pilot project, Pinewood B&B, is underway in Mäntsälä in Finland, where architects and owners are realising the full benefits of the WLT system. WLT's simplicity keeps the construction costs low, whilst its design allows for natural heating and cooling systems that reduce the building's energy consumption. The **modular construction allows components to be dis- and reassembled multiple times**, for reuse in different contexts, enhancing the lifespan of the products. In this pilot, the WLT is being paired with clay and bio-based insulation for an entirely natural construction, and the project is partnering with an academic research project into WLT.

INNOVATION



The WLT system secured its patents in 2018, and has strong potential to scale into the market and reduce the cost of building sustainable, healthy, durable, beautiful wooden buildings.

SOCIAL & LOCAL



By removing the need for adhesives, WLT allows the shortening of the supply chain from forest to construction site, improving efficiency and allowing more use of local materials in the building process.

PARTNERSHIPS



As well as working closely between the WLT producers, architects and the municipality, the project is also partnering up with an academic research project to gather data and make improvements to the WLT system going forward.

WOODEN FAÇADES

 **Sweden**

Schlyter / Gezelius Arkitektkontor



New 3D design techniques creating flexible and traceable wooden façades

Wooden façades play a vital role in the aesthetics and safety of a building, and by pairing the latest software and hardware, Schlyter Gezelius is producing sustainable building façades that allow greater creativity and require less maintenance.

By combining a tradition of wooden construction with the latest digital design techniques and high-tech industrial processes for producing wooden construction materials, Schlyter Gezelius is developing a new CLT façade system. The system allows **completely customisable façades to be designed to the specification of individual buildings**, creating unique, flexible and highly crafted façade elements. These digital designs are brought to life by matching software with the latest milling hardware, using the data files to set the saw with millimetre precision. The project has produced several successful prototypes and now that patents have been approved, 2019 will see the project ramp up to commercial scale.

Façades form buildings' first line of defence from the outside world, and are the most icon and visible part of most buildings, meaning that it's important to get them right from both an aesthetic and safety perspective. Aging, maintenance and fire safety are all causes for concern when selecting a façade, but this project's approach produces façades that deliver on all those fronts, **aging well, withstanding wear and protecting against moisture**. Schlyter Gezelius puts an emphasis on traceability of the products, and is working with the entire supply chain, from forestry through production to end-users to improve the traceability of the wood used to manufacture the façades.

INNOVATION



This project is utilising 3D design software, paired with the latest milling hardware to create entirely new ways of working with wooden façades that offer architects new flexibility to let their creativity run free.

PARTNERSHIPS



This has been a research-led project with Research Institute of Sweden (RISE) and Luleå University of Technology (LTU), bringing in collaborators from forestry, production, construction and housing developers and end-users.

ENVIRONMENT



The new techniques used here reduce the waste created during the production phase, and are built to last with very limited maintenance, meaning more efficient use of forest resources.

KORKBYG

 Aarhus, Denmark



PHOTO: KORKBYG

Using the whole tree for sustainable cork insulation

Korkbyg is producing 100% natural cork insulation for buildings that is moisture and fire resistant, providing a sustainable alternative to improving the energy efficiency of our buildings.

Insulation plays a big role in making buildings energy efficient during their operation, but little attention is often paid to the energy used during the production of insulation, and what happens to it at the end of a building's life. Korkbyg in Denmark is utilising the natural properties of cork to produce a sustainable alternative to synthetic insulation. Cork's most famous application is in the wine industry, but due to the tiny air pockets in the bark, cork is **extremely lightweight and highly insulating**, while also absorbing vibrations and sound. Cork insulation panels can be produced from side streams of the wine industry, and are easily reused and recycled at the end of their use in buildings.

Korkbyg produce 100% natural wood-based insulation panels that require little treatment and use no chemicals or adhesives. Their insulating effect matches the industry standard, but the same properties that nature has designed to protect trees' cores gives cork insulation some extra benefits. The first is a **low moisture absorption and resistance to biological corrosion, which prevents any rot or mould issues**. Secondly, as cork does not actively burn, Korkbyg's insulation acts as a fire retardant. Although the main product isn't sourced in the Nordics, Korkbyg's production processes are much less energy intensive than synthetic alternatives, which must be heated to extremely high temperatures in production.

ENVIRONMENT



Cork is a fully bio-based and renewable resource, growing back on the tree within a few seasons, which makes it much easier to reuse or recycle at the end of its life than synthetic alternatives.

SOCIAL & LOCAL



With an excellent ability to absorb sound and vibrations, Korkbyg can reduce sound pollution and contribute to a calm and healthy indoor environment for building users.

PARTNERSHIPS



Korkbyg teamed up with Partnership for Green Growth and Global Goals to provide a huge cork backdrop to signing ceremony of an agreement to accelerate action on the Sustainable Development Goals.

Public buildings

Chapter 2

Public buildings



The buildings presented in chapter two are for use by the public at large; schools, libraries, churches and cultural centres. Much of the funding for these projects comes from public funds, often at a municipality level, where local strategies are proving powerful in driving the construction of sustainable wooden buildings.

OODI

 **Helsinki, Finland**
ALA Architects & City of Helsinki



Wooden public library with citizens at the core

Oodi is a homage to traditional Finnish wooden construction, a new library and multifunctional citizens' forum for 2.5 million visitors a year that pushes the boundaries of large wooden public buildings.

As part of Finland's centenary celebrations, Helsinki is now home to Oodi, is a magnificent hybrid wooden construction and landmark that serves to refresh the city's library services for 150 years to come. The centrepiece of library, which will serve as a **flexible open public space for an estimated 10,000 daily visitors**, is a gigantic wooden bridge structure that extends out towards the Finnish Parliament across the Citizens' Square. The wooden façade consists of 2,800 prefabricated elements of local spruce, which have undergone years of aging and fire testing and optimisation. The process was data-driven using laser scanning to ensure precision of the components' production and assembly.

In Finnish homes and schools, wood is gaining traction as a sustainable building material, but large public buildings are yet to realise the full benefits of timber construction. One of the major barriers is unfamiliarity amongst authorities, so from the outset Oodi worked with the authorities to ensure the project met up to regulation, and **the resulting quality assurance procedure is publicly available to help future projects of this nature**. Built to last for 150 years, the library is a nearly zero-energy building, designed for ease of maintenance with easily replaceable wooden elements. Oodi demonstrates the possibilities of constructing public buildings using low-carbon, local building materials that last.

SOCIAL & LOCAL



Oodi is so much more than a place to borrow books, with the focus on flexible public space that can be used for a huge number of purposes from eating and drinking to watching films and theatre.

ENVIRONMENT



Using low-carbon wooden elements brings the carbon footprint of the building down to 280kg CO₂eq per square meter, and the natural properties reduce the need for HVAC, reducing energy use and increasing architectural flexibility.

PARTNERSHIPS



The process brought together a large number of players, including Aalto University who worked with the testing of elements, and the local authorities to ensure harmony between the building's design and the regulation.

HERRESTASKOLAN

 **Barkarbystaden, Sweden**
Liljewall Arkitekter & Järfälla Municipality



PHOTO: LILJEWALL ARKITEKTER

Sweden's very first school completely built with cross-laminated timber

Herrestaskolan in Barkarbystaden, just north of Stockholm, was designed to be at the frontier of sustainable construction through innovative wood construction techniques and a solar power system making the building energy self-sufficient.

Herrestaskolan was completed in 2016, and from the beginning of design phase the ambition was to become a gold-standard example of a low carbon building. The **8,200m² school has been built completely in wood using 3,100m³ of solid timber.** Both CLT and glulam have been used to construct everything from the sports hall to the library and canteen.

The school has become a fully integrated part of Barkaby, as its facilities including its outdoor activity park are open for the whole town to use outside of school hours. It has now become a beacon for wooden schools, with Herrestaskolan a centre point for architect lectures; even the school's pupils are even doing work on wood construction.

Herrestaskolan demonstrates how **public procurement can drive sustainable change**, as the municipality requested that the architects come up with a design purely from wood. To meet the challenge, the architects collaborated with experienced engineers in the UK and local consultants to design a building fit for the 21st century.

The timber construction creates a positive learning environment for Barkaby's junior citizens, and protects their future by storing 2,500 tons of CO₂eq, with the building certified to the highest Swedish Miljöbyggnad certification standard. With glulam beams over 30 meters long and CLT boards at 16 meters high, Herrestaskolan has pushed boundaries and pioneered public-driven wood construction in Sweden.

INNOVATION



To create wooden elements to the large dimensions that Herrestaskolan required, the factory had to expand with a new room, and installations were put on large springs to avoid the vibrations from transporting through the wooden slabs.

ENVIRONMENT



Custom-produced wooden elements results resulted in greatly reduced waste streams and transport requirements during the construction process.

PARTNERSHIPS



To alleviate concerns on sound, fire and moisture, the project brought together universities with both local and international consultants and engineers, developing new knowledge for use in future projects.

SKELLEFTEÅ KULTURHUS

 **Skellefteå, Sweden**
White Arkitekter & Skellefteå Municipality



Pushing to new heights through pre-fabrication and public-private partnerships

Skellefteå's new Kulturhus is demonstrating how a municipality's vision can create an environment for private investment in building huge wooden buildings with shared public spaces.

Just below the Swedish Arctic sits Skellefteå, a town with big ambitions to become one of Sweden's most sustainable and desirable towns to live in. The centrepiece of that strategy is the new Kulturhus, which broke ground in 2018, and is set to become one of the tallest wooden-framed buildings in the Nordics when it opens in 2021. Towering 19 storeys, Kulturhus will be a hub for residents to meet and enjoy music, art and theatre, with a conference centre and 208 room luxury hotel on top. Construction in cold climates brings unique challenges, but **prefabrication of components, including modular hotel rooms can take place all year round**, with easy assembly on site with no need for drilling or casting.

Wood is the natural choice in a municipality with 3 million hectares of spruce and pine forest, which refines over 350,000m³ of timber each year. In 2014, the municipality launched a timber construction strategy to ensure sustainability in Skellefteå's new buildings and to develop this vital local economy and help make Skellefteå a centre of excellence for wooden construction. The architects are using the building as a **test case for a zero carbon building** over its lifetime, and the wood used will sequester five times more carbon than is produced for the concrete foundations. Exposed timber on the interior contributes to a healthy indoor climate and reduces decorating costs.

SOCIAL & LOCAL



To build a huge structure right in the city centre with minimal disruption is a huge challenge, but prefabrication means that time on site is quiet and efficient, with the building expected to grow by three floors per week in the final stages!

ENVIRONMENT



The building has been certified "miljöbyggnad Silver", and with no casting above the foundations, will be simple to decommission and reuse the building's elements at the end of its life.

ECONOMIC



Kulturhus is a public-private partnership, and the municipality's strategy has brought in private investment that takes into account the full lifecycle costs of buildings, not just capital expenditure.

LADE SCHOOL

 **Trondheim, Norway**

Eggen Arkitekter, Betonmast Hæhre Trøndelag & Trondheim Municipality

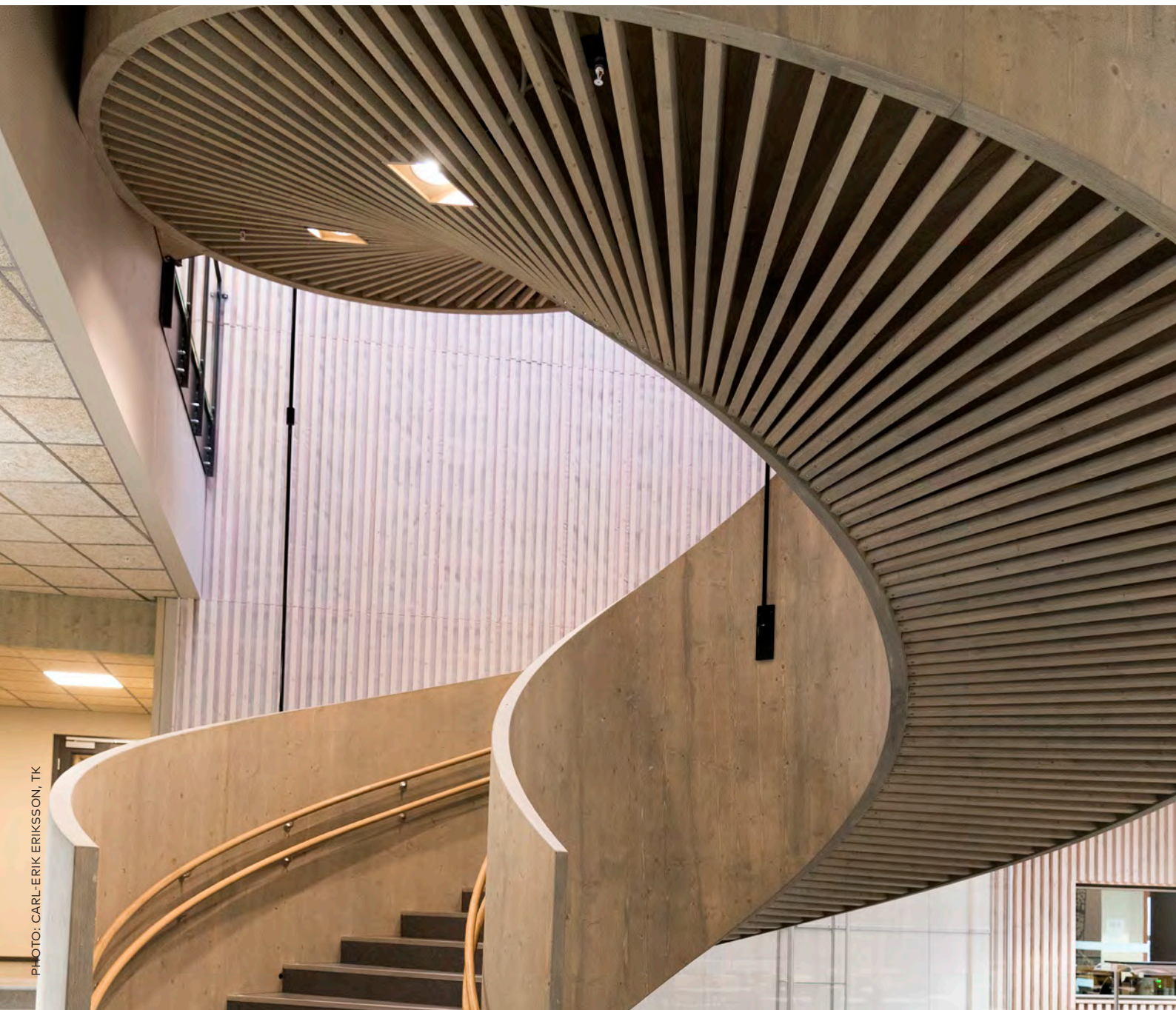


PHOTO: CARL-ERIK ERIKSSON, TK

Maximising the benefits of wood through public procurement

Lade School in Trondheim is demonstrating how municipalities can use the power of public procurement in driving change towards wood throughout the construction supply chain, reducing costs and meeting climate goals along the way.

To meet the ambitious goal of reducing greenhouse gas (GHG) emissions by 80% by 2030, Trondheim Municipality is putting low-carbon wooden buildings at the centre of its climate strategy. The municipality has now built three schools in wood, the most recent of which is Lade School, serving 740 pupils. The project proves that using the power of **public procurement can drive innovation in local building practices and supply chains**, and for this project all but one of the seven bids were for a wooden construction. By involving 39 apprentices in the school's construction, the next generation of builders in the region are gaining the knowledge and skills to work with wood from a young age.

Thanks to the wooden construction, the **GHG emissions associated with Lade School's building materials have been reduced by 39%**. A further 15% reduction in GHG emissions comes from lower energy consumption, and the building meets a passive house standard. Using wood has helped the designers to create a warm and friendly learning environment with a healthy indoor climate for the school's students, with original artwork carved into some of the wooden walls. In the early planning stages, end users contributed to the design of the building, and since completion the municipality is using the school as an example to share its expertise on low-cost and low-carbon construction throughout Norway.

INNOVATION



The masterpiece of the building is a 7.5 ton solid wooden spiral staircase, an architect's dream that was thought to be impossible was turned into reality by a small local company with the support of Innovation Norway.

ECONOMIC



As the local supply chains become more adept at using wood, financial savings are starting to be realised, aided by shorter construction times, meaning that by building in wood, Lade School saved an estimated 4.8 million NOK.

SOCIAL & LOCAL



The construction site was used to train 39 apprentices, and the building has been flexibly designed to be used by the community outside of school hours, increasing the social and economic value of the building.

KNARVIK COMMUNITY CHURCH

 **Knarvik, Norway**
Reiulf Ramstad Arkitekter



PHOTO: JUDITH CLEMENTS

Community church built with locally sourced and cost-efficient timber

Knarvik's new community church with its wooden façade and untreated pine interior uses locally-sourced materials to provide a multifunctional space for the whole community.

In the 1800s, wooden churches were a common sight in Norway, but were often painted to 'hide' their true construction material. Knarvik Community Church, opened in 2014, sets to correct that trend and retain a nod to the cultural heritage with a large timber construction that takes inspiration from its surrounding rocky, coastal landscape. With a central location overlooking the town centre, the church has become a distinct part of the town's identity, with a **pre-weathered and untreated wooden façade**. On the pine interior of the 2,250m² building, church pews have been done away with to reveal a large flexible space that can be used for cultural events housing up to 500 people, emphasising the community aspect of the project.

In addition to the environmental and visual benefits that building the church in wood brings, economics was a major driver. As construction began shortly after the economic downturn, building with **local pine transpired to be the most cost-effective way to deliver a landmark new church in Knarvik**. The key to the economic and environmental success was local sourcing, with the pine wood heralding only a short distance from the site, reducing transport costs and emissions for the project. The architects had developed their experience working with wood through earlier, smaller projects, allowing the church to be delivered without any major construction challenges, thanks in part to the rigorous involvement of the community throughout the design and construction process.

ENVIRONMENT



The pine used in the project was locally sourced and untreated, reducing transport emissions of the materials and eliminating the use of chemicals in the construction materials.

ECONOMIC



Of all the tenders put in for the church, the wooden design ended up being the most cost effective, thanks to local sourcing of materials that needed relatively little processing.

SOCIAL & LOCAL



As a community church, the building is set to serve the whole community, not just through religion, but with a flexible space that can host cultural and musical events for the whole town's benefit.

ÖSTRA SALA BACKE

 **Uppsala, Sweden**

Scott Rasmusson Källander & Svenska Vårdfastigheter



Modular wooden construction provides benefits for old and young

Östra Sala Backe's new elderly care home and kindergarten has been built using prefabricated wooden modules that create a multi-functional, flexible and healthy indoor space.

Just outside Upsalla, the new neighbourhood of Östra Sala Backe is being developed, with a focus on creating a distinct identity and social sustainability. The flagship building in the first phase of the new district is a 6,000m² multi-functional building constructed using prefabricated wooden modules. The building is designed for 24 hour use, housing 72 residential elderly care units, a kindergarten, café and restaurant, and youth social housing. **All of the end user groups were directly involved in the design phase**, and the flexibility of the space was seen to be a key feature, as the space can easily be adapted in the future to meet changing demand.

The developers, Svenska Vårdfastigheter, have begun to look to renewable construction materials, as part of their vision for buildings that contribute to a healthy, sustainable and prosperous future. With Upsalla municipality as the client, budgets had to be kept tight, but the lifecycle approach and flexible nature of the project presented long-term benefits from building in wood, and the **prefabricated and modular aspects allowed construction to be completed quickly and quietly** with minimal impact on the surrounding area. For the residents, in their golden years, using wood helps to create a natural feel and healthy indoor climate, combined with a roof garden that promotes urban biodiversity and protects against climate-induced flash flooding.

INNOVATION



The use of modular, prefabricated units allowed for a level of bespoke customisation to the end-users needs, whilst maintaining flexibility to change the space's use in the future.

ENVIRONMENT



Svenska Vårdfastigheter have been working for some time to design high-quality, low-energy buildings, but at Östra Sala Backe, wooden construction is taking the firms sustainability ambitions to the next level.

SOCIAL & LOCAL



With elderly care and kindergarten under one roof, the building's users spend much time indoors, so using wood helps to create a more positive and healthy indoor environment.

Private buildings

Chapter 3

Private buildings



Chapter three covers a broad range of private wooden buildings, from housing developments and office spaces to farms. The projects showcased here demonstrate the constant boundary pushing in the sector, with many examples of how building in wood can provide not only environmental, but also social, local and economic benefits.

LISBJERG BAKKE

 **Lisbjerg, Denmark**
Vandkunsten Architects, Hustømmerne & AL2Bolig



PHOTO: VANDKUNSTEN ARCHITECTS

Low-cost and low-carbon: the hybrid future of sustainable social housing?

Lisbjerg Bakke is a vision of what sustainable social housing in Denmark can look like. The hybrid timber construction of 40 apartments is an open source design that anyone can access, and has 70% lower climate emissions and 28% lower lifecycle costs compared to the Danish standard.

On the outskirts of Aarhus lies Lisbjerg Bakke, a 4,100m² hybrid timber building and winner of the 2014 'sustainable social housing of the future' competition. In a joint venture between the architects and engineers, the full lifecycle of the building has been taken into consideration from the outset, with a **flexible design that allows the reconfiguration of the building into new layouts** or office space, and building components that can be easily upgraded. Decommissioning has already been designed into the building, with the use of special joints meaning that Lisbjerg Bakke will be able to be disassembled with components available for reuse.

One fifth of the Danish housing market is social housing, and with municipalities as the buyers and maintainers, value for money is imperative. The **lifecycle cost of this Lisbjerg Bakke, is estimated to be 28% lower than standard social housing**, and the hybrid timber design offers 3–4% more floor space than a concrete building of the same size. The construction phase was remarkably fast, with less transport requirements creating a better working environment for the builders. The end users of the building were consulted early on in the design stage, and by utilising wood's ability to absorb moisture, those residents benefit from improved indoor climate with very low volatile organic compound levels.

ENVIRONMENT



The building materials used for this project results in 70% lower use of fossil resources – each square meter of the building has 2.3kg of carbon embedded every year, assuming a lifespan of 50 years.

SOCIAL & LOCAL



The open-source project information has been widely distributed amongst the industry and used educationally by students and housing associations. The Royal Danish School of Architecture is putting together a handbook about the project to further share the lessons learned in at Lisbjerg Bakke.

PARTNERSHIPS



The development of Lisbjerg Bakke was only possible through strong collaboration between the developers, timber suppliers, housing associations and the municipality, with end users consulted in the design stage.

KAJSTADEN

 **Västerås, Sweden**
C.F. Møller, Martinsons & Slättö Förvaltning



PHOTO: C.F. MØLLER

Locally-sourced timber tower raising the bar for sustainable construction

Kajstaden is Västerås' new landmark nine-storey timber tower, which has reduced material emissions by 44%, and created a business model that is spreading all over Sweden.

Västerås' old industrial harbour is being transformed into a new neighbourhood with nature at its heart. It is therefore fitting that **Sweden's tallest wooden-framed building** (as of 2018), Kajstaden, sits in the entrance to the new development. All load-bearing elements of Kajstaden – its walls, floors, beams, and roof – are constructed from locally-sourced CLT, using 3m tall panels that reduce the need for cutting on site, and allow for all nine storeys to have high ceilings, creating spacious and light-filled living spaces. Being a project of firsts, it is also the developers first foray into wooden construction, but is now being replicated across Sweden.

Using CLT in such an innovative way did introduce some extra costs for the developers, however these **costs were more than offset by the significantly shorter construction time**, which reduced the need for capital and loans at the construction stage. Thanks to the use of so much locally sourced wood, Kajstaden's material emissions are 44% lower than a concrete equivalent. Taking a full lifecycle approach, the components are designed to be reused in simpler products at the end of the building's life before eventually being recycled for bioenergy. This long-sighted view has led to a flexible design, with the ground floor easily convertible to commercial space in the future, as needs in the neighbourhood change.

ECONOMIC



Kajstaden has received a considerable amount of positive attention and has had a distinct effect on the market with the developers scaling to new projects around the country, proving the demand for circular bio-solutions.

ENVIRONMENT



Across the estimated 120 year lifetime of the building, the carbon footprint is calculated to be 2.2kg of CO₂ equivalent per square meter – 44% less than concrete equivalent! Additionally, the biotopic roof contributes to water management in the neighbourhood.

PARTNERSHIPS



Kajstaden stems from a research project by the Swedish Research Council for Sustainable Development, and continues in that stead with project leaders sharing knowledge through site visits and lectures at Stockholm Architecture School.

FLATEY FARM

 **Myrar, Iceland**
Límtré Vírnet



Timber-framed farm proves wood's potential in the land of fire and ice

Not far from Iceland's largest glacier, Vatnajökull, Flatey Farm has used a large timber-framed building to refresh their dairy farming operations, with reduced carbon emissions and increased welfare for animals and employees.

Iceland isn't known for its abundance of forests and timber production, however some pioneering projects are starting to utilise wood sourced from Iceland's Nordic neighbours to innovate in the rapidly growing construction sector. Since 2015 a **large timber construction has given a new lease of life** to Flatey Farm, located in the South East of the country. Taking inspiration from the local indoor football hall in nearby Höfn, a 4,700m² gulam structure on the farm houses over 200 cows in one of Iceland's largest dairy farms. The design of large wooden free-bearing frames also incorporates a natural ventilation system reducing the building's energy demand.

With sustainability at the heart of the new business model, the developers sought out FSC certified timber, which is increasingly gaining traction in the Icelandic market. Based on a lifecycle analysis of the building, the carbon emissions associated with the timber, including transport, are **93,000kg CO₂**, which is significantly less than for a building of this size constructed from concrete and steel. The wooden structure has also created a more healthy environment for both animals and workers, as well as reducing the maintenance costs over the lifetime of the building. The building was also designed to be disassembled at the end of its life in a way that it can be easily reconstructed for new purposes such as a sports hall.

ENVIRONMENT



As well as reducing the carbon emissions of the building's material's, the wooden construction generated far less waste during construction, and the design results in low energy consumption throughout its lifetime.

SOCIAL & LOCAL



The building has provided a boost to the local economy through the production of local dairy products, and the creation of an attached café aimed at the thousands of tourists regularly visiting the area.

PARTNERSHIPS



Flatey Farm has entered into a deep partnership with the local community, and welcomes regular visitors and school groups, reflecting the transparent nature of the project.

MOHOLT 50 | 50

 **Trondheim, Norway**
MDH Arkitekter & Veidekke



PHOTO: MDH

Timber towers promoting sustainable development

Trondheim's Moholt 50 | 50 project has challenged its stakeholders to contribute to sustainable development and innovation, resulting in an affordable, healthy and environmentally friendly timber student village.

Celebrating the 50th anniversary of a student village in Trondheim, Moholt 50 | 50 is a new timber hub of student life with housing units, a kindergarten, grocery store and sports facilities. The project has transformed a former parking lot, to put the emphasis on sustainable urban development for the next 50 years, hence the name Moholt 50 | 50. At the outset, conventional construction methods using concrete and steel were envisaged. However due to the project's ambitious energy and climate goals, **the project team took the decision to use cross-laminated timber (CLT) to build the 643 new student apartments.**

The five timber towers are 9-storeys and 28 meters high, using 6,500m³ of wood, making Moholt 50 | 50 the largest CLT project in Europe and one of the largest in the world at the time of completion. From the first to the ninth floor, the entire structure consists of prefabricated CLT elements, with even the elevator shafts and stairwells constructed from CLT. As a result, the carbon emissions associated with the building materials are 57% lower than if concrete and steel had been used. The project has been pioneering in several areas, but the project was still completed on schedule and on budget. **Massive wood proved competitive on price, since construction time was significantly reduced.**

ENVIRONMENT



The use of CLT has reduced the carbon footprint of the the building materials by 57% in comparison to traditional construction methods. The structures are also heated and cooled with renewable geothermal energy.

INNOVATION



A full scale fire test was conducted to establish a better information basis for fire sizing, burn rate and sprinkler capacity. Some of the structural walls are painted with a transparent fire protecting wood stain that enables the exposure of the wooden surface.

PARTNERSHIPS



Moholt 50 | 50 was a wild card in the competition, where experienced architects were invited to form teams with younger offices. Four contractors were trained in building in solid wood to be able to offer a competitive price quote for construction in this material.

VALLA BERSÅ

 **Linköping, Sweden**
Winell Jern Arkitekter & Lindstén Fastigheter



PHOTO WINELL JERN ARKITEKTER

Circular in design and materials

As an example on what is possible today for planning and constructing a sustainable building, Valla Berså has just been completed – where wood symbolises a truly sustainable apartment building.

Situated close to the center of Linköping, the newly completed five-storey apartment building Valla Berså is the very first apartment block made from CLT in Linköping. The building has set out to demonstrate **the potential for wood to pair bold architectural ambitions with high sustainability standards** in apartment buildings.

In fact, sustainability is the cornerstone of this building, which has been designed to be nearly zero-energy by utilizing both solar panels for generating electricity and geothermal energy for heating and cooling. Mobility has also been brought into the design, as a shared electric car pool is included in the rent and attractive bicycle facilities are available for all people living at the 69 rental apartments of Valla Berså.

1,800m³ of Swedish wood was used to complete the building, storing 1,440 tons of carbon. The wooden elements were delivered by a factory located 700km away from the site, where tight coordination between the on-site team and the factory resulted in fast and efficient construction process. Exposed wood is emphasised in the design, with ash wood flooring adding to the natural feel of the building. **The building was built without any weather protection at the construction site** – a rather novel methodology for wood construction.

The architects opted for a circular design of the building, which whilst bringing new challenges, delivers twice as much workable area as rectangular design. The use of wood, paired with efficient energy design delivers significant environmental benefits and is set to be awarded Silver under the Swedish Miljöbyggnad certification.

ENVIRONMENT



The building uses 1,800m³ of wood, which represents 1,440 tons of embedded carbon. The building will also be fitted with solar panels and the geoenergy to warm and cool the building.

INNOVATION



The design of Valla Berså has been optimized regarding energy usage, both in the construction and in the operational phase. Using innovative design and materials has enabled the building to be nearly zero-energy.

SOCIAL & LOCAL



The entire building is being built to use as little energy as possible, both inside the building, but also how the tenants are moving around in Linköping, as there will be access to a shared car fleet included in the rent and biking facilities in the building.

Private buildings

STRANDPARKEN

 **Sundbyberg, Sweden**
Windgårdhs & Folkhem



Modular timber apartment complex inspired by nature

In 2013 Strandparken became a flagship for wooden construction, using prefabricated timber modules clad in a cedar shingle facade to start a wave of sustainable wooden apartment buildings now appearing all over Sweden.

Located on the shore of the Bällstaviken inlet in Sundbyberg near Stockholm, the two 8-storey apartment buildings became Sweden's tallest timber buildings and one of the world's largest residential wooden developments on completion in 2013. The 25m tall timber structure is rooted on a concrete ground floor, and **so lightweight that it needed to be anchored from the very top with steel rods**. Despite this, wood dominates in Strandparken with prefabricated wooden modules giving a natural feel with softer internal acoustics. Keeping the facade visually appealing as the wood ages presented a new challenge, which was overcome through the use of cedar shingles whose natural variation offsets variation in any discolouration over time.

At the core of Folkhem's strategy is a long-term view that sees wooden construction as key to reducing risk and delivering long-term benefits. Strandparken was their first major wood project, comprising 28,000m² of CLT, 180m³ of glulam and 14,000m² of cedar shingles, with each wood type providing a distinct and vibrant identity for the building. Materials are designed for minimal maintenance, and interior walls are covered in thin gypsum board to comply with fire regulations.

With the elements prefabricated off-site, it took just seven months to complete one block – about half the time it takes to build with concrete. The construction site was innovative too, with the roof rising above each floor as the building grew to keep elements protected from the weather.

ENVIRONMENT



Analysis by the Swedish Royal Institute of Technology and Swedish Environmental Institute concluded that compared to conventional steel and concrete, Strandparken generates around half the emissions in the construction phase.

SOCIAL & LOCAL



Whilst Strandparken became Sweden's tallest timber building, the bigger priority for the developers was to push to new heights of comfort, attractiveness, and sustainability, creating affordable homes for local residents.

ECONOMIC



Strandparken was a pilot project costing 12% more than using conventional techniques and materials, but as Folkhem scales up and improves knowledge and experience with newer and larger projects, costs are coming down.

BRF IVALLA

 **Linköping, Sweden**
Omniplan & Urban Properties



PHOTO: IDA GYULAI

Timber construction enabling adaptability at a new level

BRF iValla in Linköping is using timber to push the boundaries of flexibility in building design, generating big benefits over the building's lifetime, with a local focus in its business model.

Without a crystal ball, we don't always know what we will need from the buildings of the future, even though we are building them today. As such, to create truly sustainable buildings for the long term, it's clear that the ability to adapt and change buildings will be crucial to their longevity. This is where Omniplan, developers of BRF iValla, saw the benefits of building in wood. The four-storey, 20 apartment building in Linköping has **exceptional levels of flexibility thanks to a gulam beam structure with suspended floor panels, eliminating the need for internal loadbearing walls**. The project was made possible thanks to a highly ambitious local municipality acting as a driving force for change.

BRF iValla's timber structure allows for each floor to be configured independently, and with maximum flexibility, with the stairs and elevators external to the timber frame. Plumbing, cables and the like are all housed in accessible units in the flooring, which are easily changed and extended to allow new systems to be added over time, meaning that modular kitchens and bathrooms can be shifted around with speed and ease. **Even the external walls can be adapted, allowing for balconies, doors and windows to be adjusted to the needs of the building's users**. The project has developed the idea of 'byggherregemenskaper', with a focus on distributed, local equity.

INNOVATION



The building's flexibility allows the users to think in new and creative ways of how to use the empty timber shell and adapt it best to their needs, which can change over time.

ENVIRONMENT



By using timber for so much of the construction, including wood-fibre insulation and the casing for the roof's PV panels, BRF iValla has eliminated the need for any plastics to be using the building's construction.

SOCIAL & LOCAL



By harnessing the concept of 'byggherregemenskaper', small-scale local private capital is leveraged to construct and own the building, creating positive outcomes for well distributed, local equity.

SKIPET

 **Bergen, Norway**
GC Rieber and Paal J Kahrs architects



PHOTO: MIR AS, PAAL J. KAHR'S ARKITEKT OG OG ARKITEKTER

Wood from the bottom to the top

Skipet will be one of Norway's first office buildings built in solid wood, which continues Bergen's proud tradition of wooden buildings.

Situated only a few hundred meters from what was formerly the world's highest timber construction, the wood construction named 'Skipet' (The Ship) is building on the city of Bergen's reputation as home for innovative wooden buildings. **The building is inspired by the shape of a ship with its elongated design.**

The building is designed and planned to be classified as BREEAM Excellent, the highest rating available, and will have solar panels installed at the roof, cooling system utilising the water from the nearby inlet and second-life car batteries in the basement to even out the demand for electricity from the grid.

In collaboration with Innovation Norway, a feasibility study was conducted for the use of solid wood in the building. It will be one of the first office buildings in Norway to be built in solid wood. The cross-laminated timber and glulam will be delivered from the newly established factory in Norway, thereby reducing the need for transporting the wood long distances. The factory is using wood from the Norwegian forests. The wooden structures are exposed in large parts of the building both externally and internally. **And emphasis is placed on showing that an environmentally conscious choice has been made when using wood.**

The five-storey high and 14,270m² large office building will comprise of wood from the very first floor, which is unusual for wood constructions – often concrete is used for the first floor. The use of solid wood coincides with the objectives of the municipal green strategy.

INNOVATION



Using wood from the ground floor and up is a relative unused procedure, which showcases new innovative ways of building wood constructions.

PARTNERSHIPS



The developers did a feasibility study in collaboration with the Norwegian Government's Innovation Norway to test if it would be viable to build the office building using massive timber.

SOCIAL & LOCAL



The project is making use of wooden elements produced in Norway with wood from local forests. This not only an environmental benefit, but also boosts local workplaces and economy.

MJØSTÅRNET

 **Brumunddal, Norway**
Voll Arkitekter, Moelven Limtre & AB invest



PHOTO: ANTI/JENS EDGAR HAUGEN

Recording-breaking timber tower built with local materials and expertise

Mjøstårnet in Norway is set to become the world's tallest timber building, and has developed new techniques to raise the ambitions of safe and low-carbon construction with a local focus.

Hearing the call of the 2015 Paris Agreement, Arthur Buchardt, a Norwegian property developer, began thinking about how he could lead a new age of low-carbon construction right in his hometown of Brumunddal. His answer is Mjøstårnet, which on completion is set to become **the world's tallest timber tower, at 85.4m**. The 18-storey building will be home to offices, a hotel, restaurants, apartments and a swimming pool, and has brought together various partners to set a new benchmark for tall timber buildings. The project has emphasised local sourcing of materials and expertise, with many components manufactured at a factory just a short hop along the main road.

To break records and construct a wooden building of such great height, Mjøstårnet has had to overcome numerous challenges, and use new and untested assembly techniques. Components delivered to site come predrilled, and are assembled at ground level in sections 4–5 storeys high before being lifted into place. This quick technique means that there is no need for external scaffolding – just one large crane. As a timber construction is so light, it has to be designed to withstand flex from strong wind, and is deeply anchored over 50m down to the bedrock. Fire safety has also been of paramount importance for a wooden building of this size, and **each floor forms its own fire compartment which has been tested to burn out before losing any structural integrity**.

SOCIAL & LOCAL



The sourcing of expertise and materials for Mjøstårnet couldn't be much more local, with components manufactured from local wood in a factory a short distance along the main road.

ECONOMIC



The developers hope that their world record won't stand for long, as the techniques established in this project can be scaled out into the market to establish more and more tall timber towers.

ENVIRONMENT



The 11,300m² building is a test case in low-carbon tall buildings, and the reduction in transport requirements through local sourcing is a significant way in which to reduce construction emissions.

VALLE WOOD

 **Oslo, Norway**
Lund+Slaatto Arkitekter & NCC



PHOTO: TRINE GAARDER STENBERG

Office building working with a full life-cycle focus on sustainability

Innovative wood construction in the centre of Oslo is setting a new standard for the future of office buildings.

Situated in Oslo, Valle Wood – with 6,700m² of office space – is the largest massive wood construction project for commercial use in Norway. The project has taken a holistic and highly ambitious approach to environmental protection in the construction phase, minimising energy use, waste, transport and use of chemicals. The building will have a green roof, and be **certified in accordance with one of BREEAM's highest level of certification**, which takes a full view of the building's entire lifecycle perspective. It is expected that the building will have 40% less energy consumption than similar office building, savings that can be passed on to tenants.

Valle Wood was designed with a distinct identity, to stand out from the surrounding concrete and steel buildings, thanks to its dynamic wood façade. Inside the building, wood will be the dominant material, even the elevator shaft and the stairs between the floors are made from wood. **The emphasis on exposed wood in the building aims to create a pleasant and healthy working environment.**

The glulam beams and columns are Norwegian produced, while all the massive wood panels and slabs are from an Austrian CLT producer. Assembly is around 2.5 weeks per floor, with CLT wall elements spanning over two floors. In total there will be 7 floors, taking the wood building to a height of 28 meters.

ENVIRONMENT



Constructing the office building using wood will store 1,300 tons of CO₂ eq in the structure, and the building will consume 40% less energy compared to a similar office.

SOCIAL & LOCAL



The green rooftop, visible from the street, brings a natural feel to the office and its surroundings, with the possibility of small gardens and even crop production on the roof.

INNOVATION



Valle Wood is a lighthouse project, demonstrating how maximising wood in construction of office buildings can benefit both the environment and the people working inside, and has set a new standard for office buildings in Norway.

Second-life Wood

Chapter 4

Second-life Wood



At the end of their lives, wooden buildings aren't simply smashed down with a wrecking ball, but are increasingly being designed for careful disassembly so that the wooden elements can be reused and recycled. Chapter four features two companies who are making use of these resources to give wood from construction a valuable second life.

TrÆls

🇩🇰 Hedensted, Denmark



PHOTO: TRÆLS

Finding a second life for construction industry's wooden waste

TrÆls uses waste streams of wood to upcycle furniture for sale and rent with a product as a service model, preventing wood from slipping down the value chain after its first use.

The construction industry is responsible for around a third of all the waste we produce, often due to poor forethought on how materials can be reused at the decommissioning stage. Wood from the construction industry often slips down the value chain, and quickly finds itself burned for bioenergy where the stored carbon is released into the atmosphere. However in Jutland, the Danish firm TrÆls sees only opportunity in the construction industry's wooden waste. Founded in 2015, it is totally focused on its part in the circular economy by **upcycling wooden waste into new in- and outdoor furniture for sale and rent**, keeping waste wood higher in the value chain for longer.

TrÆls source wood and other materials from the demolition of old buildings, and ties these resources with Danish design and traditional craftsmanship to create bespoke products and furniture. The carpenters then use a **reverse design process that first assesses the available materials and then designs the products to match**. TrÆls is championing products as a service, with a rental system running alongside their sales business, that massively improves the utilisation of each piece of upcycled wooden furniture and removes the need for clients to worry about storage between uses. In a bid to continue traceability of products into wood's 'second-life', TrÆls has created an online system to track products from their source to final use.

ECONOMIC



Turning wood waste from the construction industry into tables, benches, exhibition spaces and art installations and more prolongs the life and increases the economic value of the natural resource.

ENVIRONMENT



The construction industry produces around 2 tons of waste per person every year in the EU, and by finding a second use for the industry's wood waste, TrÆls is contributing to a more sustainable and circular model.

PARTNERSHIPS



TrÆls work with partners in the construction industry to source materials that would otherwise have gone to waste, and have teamed up with Hedensted Municipality to run a project to help businesses work more with the circular economy.

SAGA WOOD

 Denmark



Cascading of wood made possible through innovative impregnation

Innovative processes have enabled Saga Wood to give a second life to used wood products, without comprising the endurance and functionality of the wood.

While wood impregnation can secure a longer life-time for wood products, the process often involves the use of chemicals that not only harm the environment, but also makes it very difficult to reuse the wood. Saga wood has focused on solving that dilemma by using impregnation made from 100% natural linseed oil derived from flax seed. The unique feature of Saga's impregnation is that the linseed oil is refined with egg whites, stearin and paraffin. This means that the oil can penetrate effectively into the wood and form a **strong membrane that protects and minimizes moisture absorption.**

This approach will enable the reuse of impregnated wood, and allow more wood to be recycled without slipping so far down the value chain. Furthermore, Saga Wood is using recycled wood from demolition projects and has been able to document that it is possible to treat this wood with oil and heat in order to reuse the wood. This has been implemented in a project for Copenhagen City.

Saga wood has specialised in providing wood for facades, terraces and fences, all using raw wood material from Nordic forests. By using only either PEFC or FSC certified wood, Saga ensures that the wood is sourced from sustainably managed forests. A patented process for **low-energy heat treatment of wood that is free from the use of chemicals** has given the products a Nordic Swan ecolabel. These certifications ensure that Saga Wood's environmental impacts are considered at every stage of the value chain in a full life cycle assessment. The company is expecting to open a new factory in Norway, nearby the forests which provide the material for the production, reducing transport requirements and further boosting the sustainability credentials.

INNOVATION



Saga Wood is doing pioneering work to successfully introduce a process that uses second-hand wood from demolition, thereby keeping the wood in use for as long as possible, and using natural resources in a responsible manner

ENVIRONMENT



In Denmark alone, around 180,000m³ wood from demolition is returned to recycling centres, much of it unfit for reuse, but if just 25% is reused it could potentially mitigate 90,000 tons of CO₂ emissions annually.

PARTNERSHIPS



Saga Wood is working closely with architects and constructors to optimise the use of wood at all phases of the life cycle, with benefits for the end user and the environment.

Methodology

The creation of this report showcasing 25 good practice cases of the use of wood in construction was a multi-phased process from concept development and outreach, to project scoring and choosing the 25 best examples. This process was co-developed by the Nordic Wood in Construction Secretariat and the consultancy Nordic Sustainability. The process is based on the Nordic Council of Ministers' report "Nordic Bioeconomy 25 cases for sustainable change" from 2017.

Methodology development

In developing the methodology framework, Nordic Sustainability and Wood in Construction Secretariat consulted, among others, the Secretariat's advisory board and experts within the field.

The resulting five criteria and 15 sub-criteria set the basis for assessing the projects. The criteria here, should be seen as work in process and non-exhaustive. However, the criteria do provide an excellent starting point to assess the different projects across value chain.

In the text boxes, we outline the five criteria and related assessment questions for applicants that were used to evaluate the applications.

INNOVATION



The case demonstrates innovation through its use of technology, business model, and benefits achieved across the value chain.

1. How does the case encourage new technology or adapt existing technology in an innovative way?
2. What makes the business model innovative, from a local, regional, or global perspective?
3. How does the case include design or architectural improvements with benefits across the value chain?

ENVIRONMENTAL BENEFITS



The case benefits the environment through mitigating climate change, integrating circular principles, and addressing biodiversity.

1. To what extent does the case have potential to mitigate climate change?
2. How does the case contribute to sustainable and circular use of wood?
3. To what extent does the case address biodiversity?

SOCIAL & LOCAL BENEFITS



The case documents economic value, health and liveability benefits, and competence creation in the local community.

1. How does the case generate economic value in the local context?
2. How does the case create health and liveability benefits for users or the local community?
3. How does the case build skills and competencies in the local community?

ECONOMIC VIABILITY



The case shows the potential to save costs and time across the value chain and scale in new markets.

1. How does the case have the potential to save costs with Life Cycle Analysis or Life Cycle Cost perspectives?
2. How does the case enable time and efficiency savings across the value chain?
3. How does the case have the potential of scalability into new markets?

PARTNERSHIPS



The case engages with cross-sector and value chain partnerships while operating in a transparent and accountable manner.

1. To what extent does the case engage with partners in other sectors?
2. How does the case collaborate and work across the value chain?
3. How does the case operate in a transparent and accountable manner towards partners and society?

Who was eligible?

In order to set a common ground for project applicants, the following criteria had to be met for project to be eligible for the final report:

- The project must have a clear role in the use of wood in construction of buildings
- Where applicable, buildings must have a substantial use of wood
- The project must already be commenced and building(s) should be under construction
- The project must be in the Nordic region

Scoring of the applications

The scoring was based on the five criteria and 15 sub-criteria and executed by the Wood in Construction Secretariat. The total of 15 sub criteria were given the scores High (3), Medium (2), and Low (1), allowing a combined top score of 45 and low score of 15. Applicants were scored on the basis of their provided information. The final 25 cases were selected from the highest scores, accounting for geographical and value chain spread.

DISCLAIMER: The applications have been assessed and the cases written based on the submitted information. No additional research has been carried out during the scoring to validate the given information. The data featured in this case catalogue is correct to the best of our knowledge and based on research as well as information and clarifications provided by the applying organisations and companies.

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The Nordics have the resources, experience and the will to build sustainably with wood.

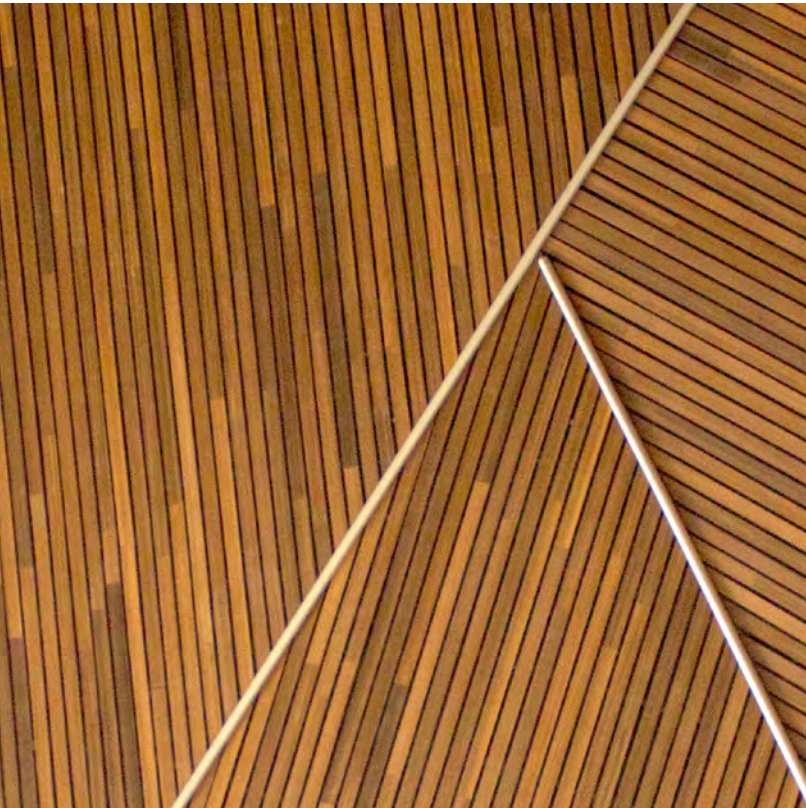


PHOTO: UNSPLASH AND ALIOTHATEK

Nordic Wood in Construction Secretariat

The Nordic Wood in Construction Secretariat is an initiative commissioned by the Swedish Government and the Nordic Council of Ministers in 2018, hosted by EIT Climate-KIC Nordic and supported by a pan-Nordic advisory board. Our primary aim is to support further development of the use of wood in construction in Nordic countries, contributing to the UN's Sustainable Development Goals. This is achieved by undertaking a portfolio of projects to identify and break down barriers to using wood in construction, sharing knowledge, and increasing cooperation amongst Nordic stakeholders from the private sector, public sector, and academia.

More information can be found at www.woodinconstruction.net

EIT Climate-KIC

EIT Climate-KIC is a European knowledge and innovation community, working to accelerate the transition to a zero-carbon economy. Supported by the European Institute of Innovation and Technology, Climate-KIC identifies and supports innovation that helps society mitigate and adapt to climate change. They bring together partners in the worlds of business, academia, and the public and non-profit sectors to create networks of expertise, to create the innovation that leads to systemic change.

Nordic Sustainability

This project has been completed in partnership with Nordic Sustainability. Nordic Sustainability is a value-based consultancy working at the intersection of strategy and sustainability. The consultancy is the first Future Fit Business Benchmark accredited consultancy in the Nordics and works with international organisations, foundations, and companies at a Nordic and global scale.



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Wood in construction – 25 cases of Nordic good practice

Building with wood has an untapped potential to transform the construction industry and create the next generation of low-carbon and healthy buildings. The Nordics, with an abundance of sustainably managed forest resources and a long history of building in wood, are well placed to lead in this construction revolution. Across the wood in construction value chain, from forestry and processing, through production and design, to construction and decommission, the Nordic region is innovating to build bigger and more sustainably with wood than ever before.

This publication features 25 Nordic cases from across the value chain working with wood in exciting and innovative ways. These projects demonstrate the benefits and drivers for building with wood, and provide inspiration for architects, land managers, city planners, designers, suppliers and many more. The 25 cases point to five trends within Nordic wood in construction that paint a picture of where the industry is headed: 1) multifunctionality; 2) saving time and costs; 3) investing in scalability; 4) pushing the boundaries; and 5) circular design.

The team behind this report – the Nordic Wood in Construction Secretariat – is an initiative commissioned by the Nordic Council of Ministers and the Swedish Government, and hosted by EIT Climate-KIC. The secretariat's aim is to support and accelerate the use of wood in Nordic construction through a portfolio of projects, fostering greater dialogue, knowledge-sharing and collaboration between stakeholders from the private sector, public sector, and academia.