

For immediate release

Eco Homes Direct, part of Economic Forestry Group Ltd. (EFG)

October 11, 2023

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Engineered timber systems guide ‘green shift’ to low-carbon homes

CARDIFF, UK: Next month, the UK is due to release a Timber in Construction Policy Roadmap, which outlines how the government plans to promote the safe expansion of timber construction and remove barriers to building with timber.

The Roadmap has been widely welcomed as a huge opportunity to decarbonise construction and achieve the industry’s 2050 Net Zero target. It builds on a report released last year by the government’s Environmental Audit Committee (EAC), which called for urgent action to reduce the levels of CO₂ in construction and recognised the potential of timber as a low-carbon construction material.¹

If timber frame was used to build 270,000 new houses, the UK’s Climate Change Committee estimates that the amount of carbon sequestered per year could increase to three million tonnes of carbon dioxide equivalent (MtCO₂e) while reducing embodied emissions by 20% per building.

Expanding timber construction also offers a range of economic benefits, according to the Confederation of Timber Industries (CTI), helping regions to ‘level up’ with green jobs, and create localised manufacturing bases across the country.

A relatively new entrant to the debate is Reinforced Autoclaved Aerated Concrete (RAAC), which government agency the Health and Safety Executive (HSE) warned in August 2023 was life-expired and “liable to collapse without notice”. The warning came just days before the start of the academic year, impacting at least 156 schools.

The HSE’s warning relates to lightweight concrete planks and panels used primarily in structural applications for flat roofing, floors and walls between the 1950s and mid-1990s. It must be stressed that these aerated



Spruce House by architects ao-ft is located in a conservation area in Walthamstow, London. The house is built with cross laminated timber.
Image courtesy of ao-ft



concrete products, known in the trade as Aero Bar, are past their expected service life and have not been used in these applications in the UK for decades. "It should be no great surprise that planks made in the 1960s did not have the same levels of quality control as we would expect today," commented Christian Stone, Professional Scientist and Technical Expert at Concrete Preservation Technologies (CPT).²

However, the extensive remedial work needed in buildings at risk of RAAC failure has led building owners, architects and developers to take a fresh look at the benefits of building with wood.

"How about replacing all of the RAAC with cross-laminated timber?" suggested Joe Giddings, co-founder of the Architects Climate Action Network (ACAN) and UK networks lead at Built By Nature, who advocates the decarbonisation of the UK's built environment. "It's strong, durable and full of carbon sequestered by trees. Factory produced panels can be quickly assembled on site."



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Joe Giddings, Architects Climate Action Network and Built By Nature.

Image courtesy of Melchior Overdeest

Cross-laminated timber (CLT) may appear to be a modern solution, but the technology has been available since the early 1990s when it was developed in Austria. It is perhaps the best-known member of a family of structural engineered wood products known as mass timber, which can replace concrete and steel in modern construction. Valued at \$1.28 billion in 2022, the global CLT market is projected to reach \$5.03 billion by 2032, according to a report by Spherical Insights & Consulting.

Mass timber and CLT systems have entered the public consciousness over the last 10 years or so, as architects and developers compete to build ever-taller timber towers known as 'plyscrapers'. As the technology matures, these flagship projects have inspired governments and businesses alike as they step up efforts to meet Net Zero targets.

CLT and other mass timber elements such as glued laminated timber (glulam), laminated veneer lumber (LVL), and parallel-strand lumber (PSL) are composed of oriented layers of wood, usually larch spruce or pine, that are bonded and cured under pressure to form panels or beams. This process enhances the natural properties of timber by improving its strength, stability and durability. While mass timber can be built to similar strength ratings to concrete and steel, it is 5x lighter than concrete and 15x lighter than steel.³

Design revolution

According to the Council on Tall Buildings and Urban Habitat (CTBUH), there were 139 mass timber buildings around the world of eight stories or higher as of February 2022. The tallest at 86.6 metres (25 floors) is Ascent in Milwaukee, Wisconsin, which has 259 luxury apartments, retail space, an elevated pool with operable window walls, and a sky-deck.

Ascent is a hybrid building with a modern concrete base, elevator and stair shafts, while the rest of the structure is made from CLT and glulam. CTBUH noted that the incorporation of glulam and CLT elements allowed the natural qualities of wood to be displayed for occupants wherever possible in a 'healthy buildings'





technique known as biophilic design. This contributed to Ascent exceeding Milwaukee's conservation code requirements.

Unlike Ascent, Mjøstårnet in Norway is an all-timber structure. Standing at 85.3 meters (18 floors) it is the world's second tallest timber building, housing apartments, a hotel, swimming pool and restaurant. Norwegian timber specialist Moelven Limitre AS produced and installed glulam columns, beams and diagonals for the primary load bearing system. CLT was used for the elevator shafts and balconies, and Trä8 deck slabs for the floors up to level 11. In total, the building contains 2,600 m³ of timber structures.

Timber, which has the lowest embodied energy of any mainstream construction material, locks up carbon during the wood product's service life which means a shift to wooden structures offers the potential to significantly reduce the construction industry's carbon footprint. It also increases the number of trees grown in sustainably managed forests, requires comparatively little energy to harvest and process, and displaces more carbon-intensive materials.

These green benefits have proved to be key drivers in the adoption and development of mass timber. According to Moelven, using timber in the load-bearing structures can reduce emissions from material production by up to 85%. Korb + Associates Architects, designer of Ascent, estimates that timber used in the building sequesters the CO₂ equivalent of removing 2,400 cars from the road for a year.

Mjøstårnet stands on the shores of lake Mjøsa as a symbol of the 'green shift', according to Moelven, as it proves that tall buildings can be built using local resources, local suppliers and sustainable wooden materials.

Not just a race to the top

The focus on tall timber has reinforced a perception that Europe leads the way in mass timber construction, especially as Austria is widely acclaimed to be the birthplace of CLT.

In 1994, engineer Gerhard Schickhofer presented a PhD thesis at Graz University of Technology that paved the way for a product called brettsperrholz. This, with the help of a sawmill industry grant, led to the formation of KLH Massivholz and the commercial development of CLT. However, the US has also laid claim to launching the concept with a patent filed by Frank J Wars and Robert Watts of Tacoma, Washington in 1923.



Mjøstårnet in Brumunddal, Norway, a symbol of the 'green shift'.

Image courtesy of Voll Arkitekter AS





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Ian Campbell,
Director, Eco Homes
Direct and Titan
Timber

Whether the US or Austria wins the birthplace accolade, there can be no doubt that North America has fully embraced the potential of mass timber, given its culture of building with wood, its established wood products industry and favourable regulatory framework, and the suitability of its local forest resource to produce green, healthy architecture with beautiful aesthetics.

“Engineered timber has been in use for decades in North America and they are highly advanced in mass timber production at scale,” said Ian Campbell, director of Eco Homes Direct. “The buildings might not be the tallest, but in terms of building with timber across the board, including modular systems and timber frame, North America is a world leader in terms of usage of wood per capita in construction.”

Industry association WoodWorks has calculated that 1,753 mass timber projects were built or in development in North America as of March 2023. While European mass timber imports were used for some projects, notably CLT as the jurisdiction developed its own manufacturing industry, North America is expected to reach an annual CLT production capacity of 67 million cubic feet by 2024.⁴

British Columbia in particular has taken a leading role in showcasing mass timber, building its eight-level Wood Innovation and Design Centre in 2014 to serve as a gathering place for researchers, academics, and design professionals generating ideas for innovative uses of wood. Another of the province’s flagship projects is the Brock Commons Tallwood House at the University of British Columbia in Vancouver, built with



British Columbia is a world leader in the fabrication and design of mass timber infrastructure, with more mass timber buildings per capita than any other place in North America, according to the provincial government. The Wood Innovation and Design Centre in Prince George, (pictured), built in 2014, is an early example.

Image courtesy of Michael Green Architecture

components supplied by Penticton-based Structurlam (since acquired by Mercer). Completed in 2017, four months faster than a typical project of its size, the 18-storey building houses over 400 students.

Campbell believes that North America’s accelerating uptake of mass timber is based on its deep-rooted cultural connection with wood as a building material, leading its architects to create stunning interiors by exposing the mass timber structure.

“North Americans understand better than anyone the aesthetic, acoustic, thermal and healthy living benefits of mass timber,” he said. “It’s all about DfMA [design for manufacture and assembly] and MMC [modern methods of construction], and it’s embedded in the psyche of anyone who builds or manages timber build projects.”

Europe has approximately 70 manufacturers in 18 countries, including major players Binderholz, KLH Massivholz, Stora Enso and Mayr-Melnhof Holz. Currently there are none in the UK, although in 2022 Binderholz took over UK forestry and sawmilling group BSW.





At the time, owner Reinhard Binder described producing CLT with the group's own sawn timber in Great Britain as a priority and "motto" for the company. Binderholz has also invested heavily in the US, acquiring Klausner Lumber One and Two in 2020 and 2021.

The 'green shift'

While architects compete to design the world's tallest timber tower, including Danish studio Schmidt Hammer Lassen's proposed 100-metre housing block in Switzerland, timber technology is also gaining traction in the residential market.



Interior with exposed timber elements at Arbora, a multi-family project in Montréal's Griffintown. Image courtesy of Think Wood

As engineered wood products are factory-produced to precise specifications, they enable architects and structural engineers to push the boundaries of design by enabling the creation of large, open habitable spaces without vertical posts or large steel structures. Glulam, for example, can be moulded into curves, is highly fire retardant and has a strength to weight ratio of 1.5-2 times that of steel.⁵

Building with timber also makes the best use of the material's natural thermal, acoustic and aesthetic properties, as well as its ability to withstand lateral loads such as high winds and earthquake-related forces without distorting or breaking.



Self-build project, design phase ©Eco Homes Direct

According to Campbell, timber systems are becoming increasingly popular with architects, developers and self-builders as they bring several build advantages in addition to their environmental and design credentials.

As with the world's largest timber buildings, the ability to precision engineer timber systems under factory conditions is highly accurate, producing better buildings and reducing waste. The lighter weight of the timber elements and faster build time lowers construction and transport costs. As CLT components weigh approximately 30%

less than concrete equivalents, the area needed for the foundation footprint is smaller, which in turn reduces crane and heavy equipment needs.⁶

"In this climate of higher interest rates and inflation, more and more people are considering self build and more national contractors are considering offsite MMC [modern methods of construction] because time is money," Cambell said.





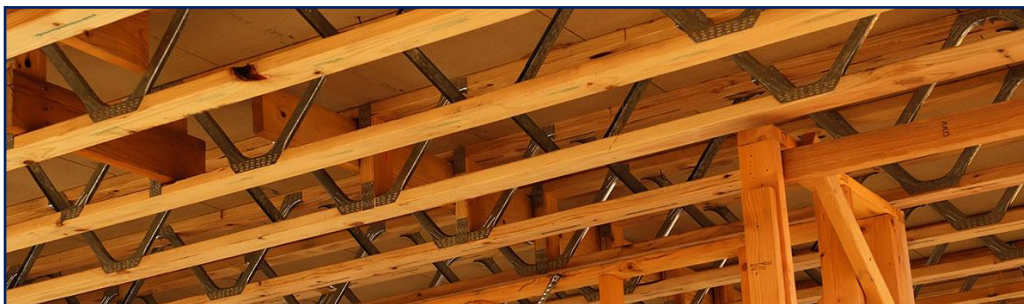
Eco-Homes Direct is one of a number of UK companies that supplies and erects whole house timber frame systems, but it is the only one that offers the Canadian Super E build concept featuring unique closed panel walls. Unlike open panel timber frame systems, where insulation and internal boarding are fitted on site, insulation and airtight barriers for closed panels are factory fitted. The cost is generally no more than a brick and block equivalent project, but the faster build time, along with energy savings over the life of the house, equates to an overall saving of, on average, approximately £2,000 per year.

An Eco Home may not stand 25 storeys high, but it makes full use of engineered wood products including panels, floor and roof cassettes, glulam for purlins and ridge beams, and metal web joists (MWJs).

MWJs epitomise the advantages of timber technology, as they optimise the use of the resource while improving build quality. The joists feature metal webs with a timber top and bottom chord, making them, strong, stable, light and suitable for extended spans. Widely used for the installation of floor, roof and ceiling systems, the open webs accommodate services such as plumbing and electrical wiring without the need to drill holes and jeopardise strength.

“An offsite MMC made in the factory using a closed panel system with airtight barriers would be up to 50% faster from start to move in, compared to a typical brick and block build,” Campbell said.

“The build quality is 100% accurate and precise. Everything done in the factory is precision made. The work is scheduled so everything can be delivered on time, avoiding expensive issues on site such as weather delays and reducing skilled labour costs.”



Metal web joists, also known as Posi Joists, in an Eco Home roof system.

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From forest to family

Eco-Homes Direct is part of the Economic Forestry Group Ltd. (EFG), a family of companies that has its own global softwood and engineered wood products sourcing organisation, Titan Timber Ltd. Titan offers comprehensive import and export services to suppliers and buyers in Canada, the Nordics and the Baltics.

“All the suppliers we work with in Scandinavia and Canada have already either set up new plant to make glulam or CLT products, or are using innovative processes to deconstruct and refabricate the fibre to make a stronger product,” said Campbell, who noted that suppliers of these advanced products differentiate their sales strategies from the commodity, price-driven market that has traditionally been associated with construction timbers.

“There is a desire to have a separate approach,” he said. “It is about talking to architects and clients as to their aspirations and delivering an improved final product. That’s where we come in, as all the major UK importers that we deal with see this new wave of added-value products as integral to securing the future of the timber industry.”





All Titan's products are sourced from sustainably managed forests certified to Forest Stewardship Council (FSC) and Programme for the Endorsement of Forest Certification (PEFC) standards. Titan also employs rigorous checks to ensure that no resources or raw materials from sanctioned countries such as Russia enter its supply chain.

"Mass timber has become increasingly acceptable for high rise buildings," said Campbell. "Some of the tallest in the world currently being built continue to highlight the importance of timber construction in mitigating climate change."

"Not only have these buildings advanced mass timber technology, they have also raised awareness of the benefits of timber construction across all housing types. This build method brings efficiencies and cost savings to self-builders and developers, and more importantly, it is absolutely the right way forward for the future of our planet."



Spruce plantation harvesting and replanting in the lower St. Lawrence, Québec.

Image courtesy of The Forest Time, Forêt Investissement

1 'Emissions must be reduced in the construction of buildings if the UK is to meet net zero, MPs warn', UK Parliament, Environmental Audit Committee, May 26, 2022;

2. Expert reaction to situation with RAAC in school buildings, Science Media Centre, September 6, 2023;

3. Mass Timber and Sustainability, Kirksey Architecture, April 11, 2023;

4. Mass Timber Production in North America, Forisk Consulting, July 21, 2023;

5. 'Laminated Timber; What's Best for You?', International Timber, September 2023;

6. 'Mass Timber in Construction - Big Buildings, Smaller Carbon Footprint', by Justin Cheng, Sustainalytics, April 14, 2022.

About Eco Homes Direct

Eco Homes Direct Ltd. designs, supplies and builds eco-friendly precision-engineered low energy timber framed homes for self-build and property developers. Prefabricating most of the house in factory conditions ensures accuracy, reduces labour and waste on site and improves efficiency to keep costs low without compromising on quality. The system's unique fully integrated closed panel timber engineered wall system exceeds UK building regulation specifications, yet an Eco Home can be erected in just one day, offering an affordable passive house solution to all. ecohomesdirect.co.uk





About Canadian Super E®

Eco Homes Direct is the UK's gateway to the Canadian Super E® build concept, incorporating a sound approach to 'fabric first' principles and an integrated focus on insulation, airtightness and controlled ventilation to deliver truly affordable, low energy, healthier homes for all. Canada is the birthplace of the original passive house concept, which was developed in 1976 by engineer Harold Orr. Since the first passive house was built in Saskatchewan in 1977, the technology and build concept has been adopted worldwide, promoted by the Canadian government's Super E® team. Hundreds of Super-E homes have been built in the UK in recent years.

About Economic Forestry Group Ltd. (EFG)

Eco Homes Direct is part of the Economic Forestry Group Ltd. (EFG), which spans the entire timber supply chain from forest to family home. Through its timber sourcing company Titan Timber Ltd., EFG supplies structural timber and wood products from well-managed, sustainable forests that adhere to strict environmental governance and are certified to Forest Stewardship Council (FSC) and Programme for the Endorsement of Forest Certification (PEFC) standards.

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