

TIMBER BUILDINGS

TRULY SUSTAINABLE REAL ESTATE



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KEY TAKEAWAYS



Greater energy efficiency and 20% fewer carbon emissions during the building lifecycle than other materials



Financially attractive due to **rising occupier demand for greener buildings which delivers a 9% rental premium**



Prefabrication potential can result in 60% fewer vehicle movements and 25% faster construction time than concrete buildings

Climate change is a major issue for real estate.
Timber buildings are part of the solution the industry needs.

As a renewable resource, timber is a truly sustainable material. As this report will show, its benefits include reduced energy consumption, fewer carbon emissions, healthier spaces, and more sustainable forest management.

For these reasons interest in using mass timber, short for 'massive timber', for construction projects is increasing significantly. Despite this, mass timber is often still perceived as daunting by many in the real estate industry compared with more conventional building materials such as concrete and steel.

We firmly believe timber buildings are a viable solution to help mitigate climate change, one which also provides performance benefits to investors, developers and occupiers.

This report sets out our rationale for this belief. It seeks to educate the industry in order to accelerate momentum towards timber buildings. It demonstrates why timber buildings are so financially and environmentally attractive and debunks common misconceptions around wood.



What is mass timber?

Mass timber encompasses products of various sizes and functions, like glue-laminated (glulam) beams, and laminated veneer lumber (LVL). The most common and most familiar form of mass timber and the type that has opened the newest architectural possibilities is cross-laminated timber, more commonly referred to as CLT.

These engineered timber products are versatile and support innovative flexible design and architectural approaches. It is this flexibility, combined with their increasing popularity to both occupiers and investors that has made engineered timber a viable alternative to concrete and steel.

The European engineered timber construction market has been growing by roughly 8% (€5 billion) a year. It is expected to expand to €10 billion a year by 2030¹. These figures concern multi-storey buildings only. If timber frame buildings and detached houses are also included, the size of the investible market increases significantly.

ENGINEERED WOOD PRODUCTS USED

		
CLT	GLULAM	LVL

1. Dasos Capital, Wood building and real estate impact investing, Q1 2021



Climate change A major real estate issue

Climate change is perhaps the most pressing issue facing humanity, with real estate being a big part of the problem. Population growth and urban expansion are putting increasing pressure on our planet's finite resources. To keep pace, it is estimated that two billion square metres of new building stock globally will be required every year between 2019 and 2025 alone. This is almost double the current amount of retail, office and industrial space in Europe according to RCA².

Figure 1 shows that the average energy consumed per person has been rising steadily over the last 54 years. With the global population forecast to rise by 25% by 2050, the need to reduce energy consumption and carbon emissions is imperative.

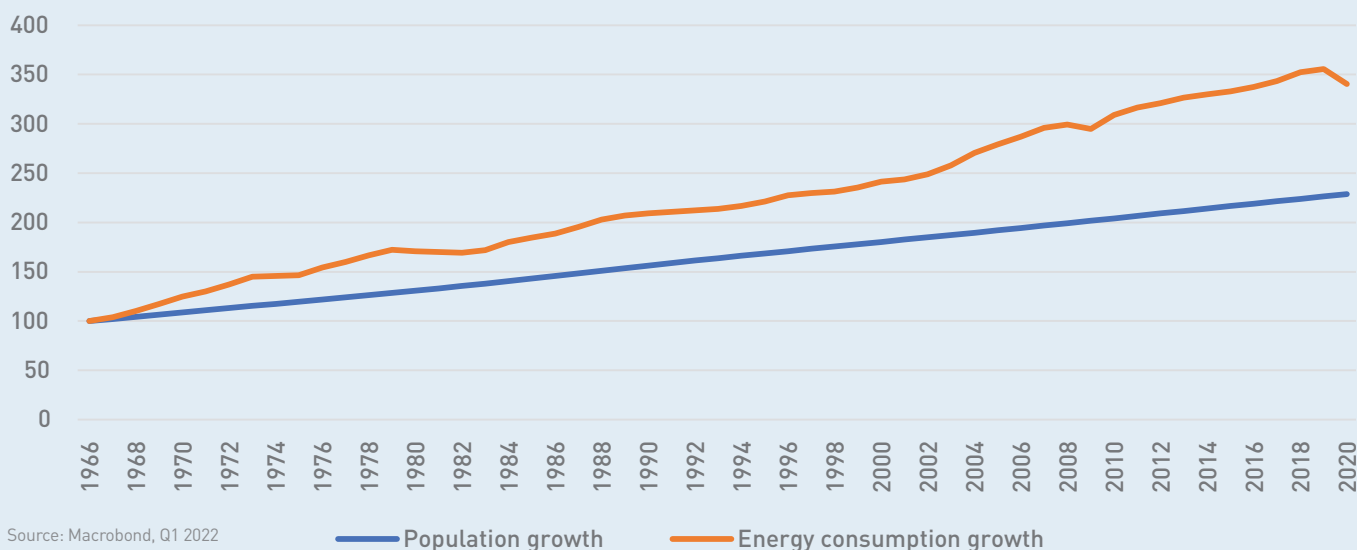
The climate crisis has been building over the last few decades with scientists, research bodies, educational institutions

and governments declaring a climate emergency in 2019. These declarations were followed by subsequent changes to sustainability targets and new legislation, with many more promised.

Real estate accounts for approximately 40% of global greenhouse gas emissions³. Left unchanged, urbanisation and the ever-increasing demand for new buildings and energy will see real estate's negative impact continue.

The United Nations Environment Programme (UNEP) estimates the real estate industry has the greatest potential to reduce greenhouse gas emissions across all industries. This creates a huge opportunity for real estate to deliver meaningful positive impact for humanity.

Figure 1 Global population forecast vs global energy consumption (Index, 100= 1966)



Source: Macrobond, Q1 2022

2. Navigant Research, Commercial and Residential Building Floor Space by Country and Building Type, 2014- 2024.

3. LGIM, Real Estate: Net zero carbon roadmap, December 2020

Sustainability Growing interest on many fronts

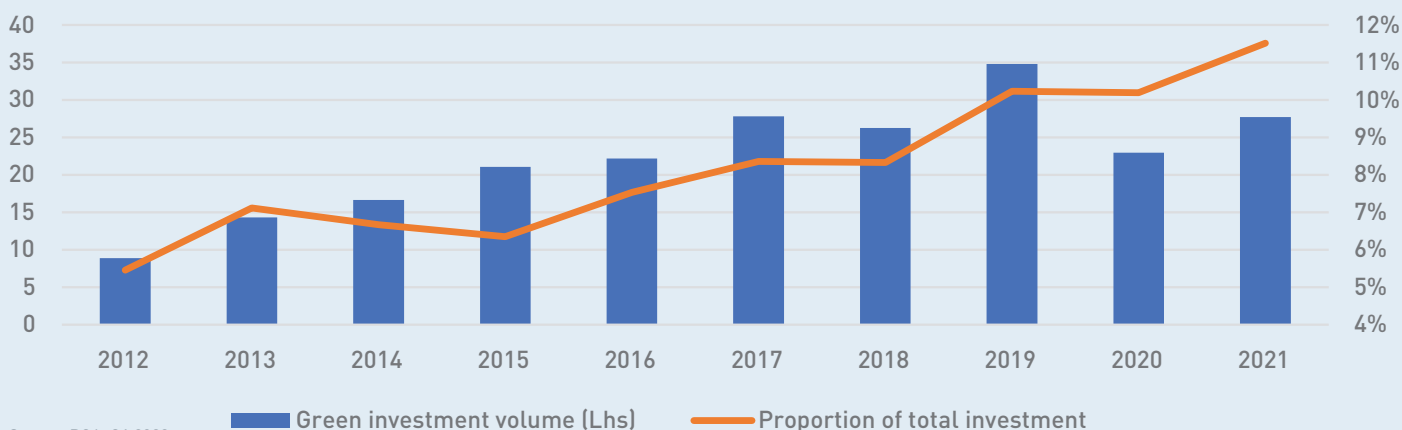
Government policies regulating the energy performance of new buildings are an impactful way of reducing emissions. They are being introduced by an increasing number of countries. The EU has established the 'Green Deal' in order to make the Eurozone climate neutral by 2050 and leading cities are also introducing city-level regulations.

Future legislation will incentivise sustainable buildings with regulatory and tax changes favouring sustainable investments and disadvantaging those that are not. Notably, 91% of global

institutional investors have stated their intention to increase sustainable real asset allocations over the next five years⁴.

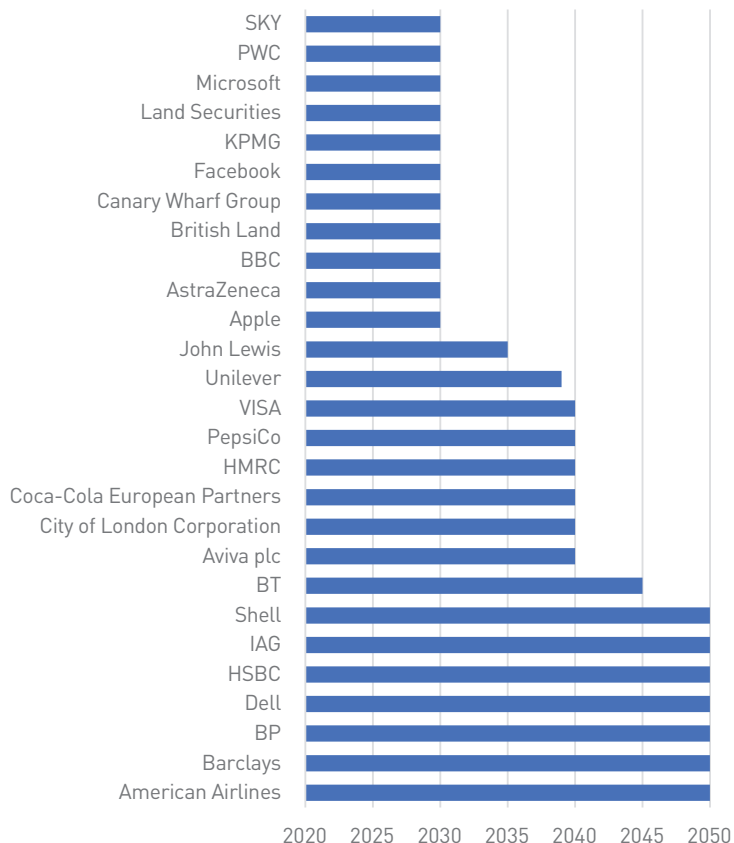
Figure 2 shows the volume of capital invested into green-rated buildings has significantly increased between 2012 and 2019. The COVID-19 pandemic resulted in a fall in total real estate investment overall but green building allocations were more resilient. Green building investment is expected to exceed pre-pandemic levels in 2022 and 2023 as investor interest grows, leading to further yield compression.

Figure 2 Investment into European green real estate (€ billion, %)



Source: RCA, Q1 2022

Figure 3 Corporate net zero declarations: A range of commitments



Source: Carbon Intelligence, Q1 2022

Climate change is shaping corporate values, choices, and investment decisions. Figure 3 shows a selection of the global companies which have already declared net zero goals. Many more will follow.

As the real estate footprint of occupiers impacts significantly on corporate emissions, particularly for knowledge or service-based companies with office-dominant portfolios, this will likely be reflected in leasing activity.

Landlords and occupiers are aware they will be judged on the environmental performance of the buildings they own and occupy. Investors are simultaneously seeking to ensure their capital is being used to prompt sustainability to help alleviate climate change and align to market appetite.

4 Macquarie Asset Management, Infrastructure and Real Assets, 2020

Timber buildings

The environmental solution

Construction is a valuable economic enabler as well as a major source of carbon and other greenhouse gases. Embodied carbon is responsible for around 10% of global greenhouse gas emissions. Unlike operational carbon, which can be reduced through energy efficiency measures and using more renewables, embodied carbon is locked into buildings through current construction methods.

Each year, more than 6 billion sqm of buildings are constructed using carbon intensive materials such as glass, iron, steel and concrete⁵.

One way to balance the need to build against the need to control emissions is through more sustainable construction methods. This has led to a return to one of the world's oldest building materials: timber.

The potential of this versatile material is immense and can be used across all sectors. Timber buildings use less energy and emit less carbon over their lifecycle than materials used for concrete-framed construction. All timber buildings store carbon regardless of their frame, insulation, or cladding materials. The largest potential for storing carbon can be achieved in external walls, intermediate floors and roof structures.

Less fossil fuel energy is needed to manufacture timber products compared to traditional materials. According to scientific studies, the production of concrete causes up to ten times higher carbon emissions than timber products. With steel, the difference is far more significant (Figure 4).

For example, a lifecycle impact study across four similar five-storey apartment blocks in Kuninkaantammi, Helsinki, consisting of two in timber, and two in concrete, found that the timber buildings produced 20% fewer carbon emissions⁶.

Timber's carbon storing capacity is also superior to traditional construction materials. Figure 5 shows how a net reduction of carbon emission can be achieved in construction by increasing the proportion of timber-based materials relative to other materials.

On this basis, it is clear how timber buildings offer so much potential to assist the real estate industry combat its sizeable contribution to climate change.

Figure 4 Carbon footprint produced by construction materials (kg CO₂e/ton)

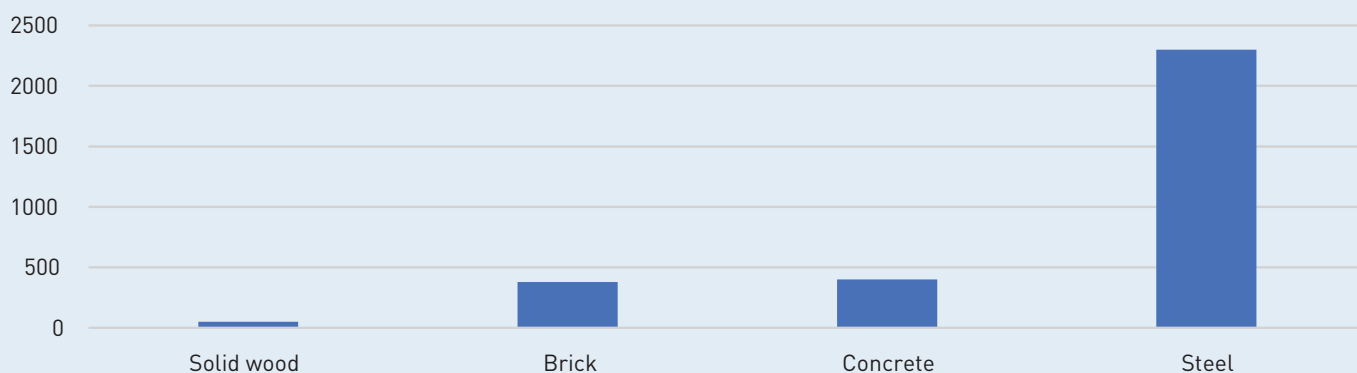
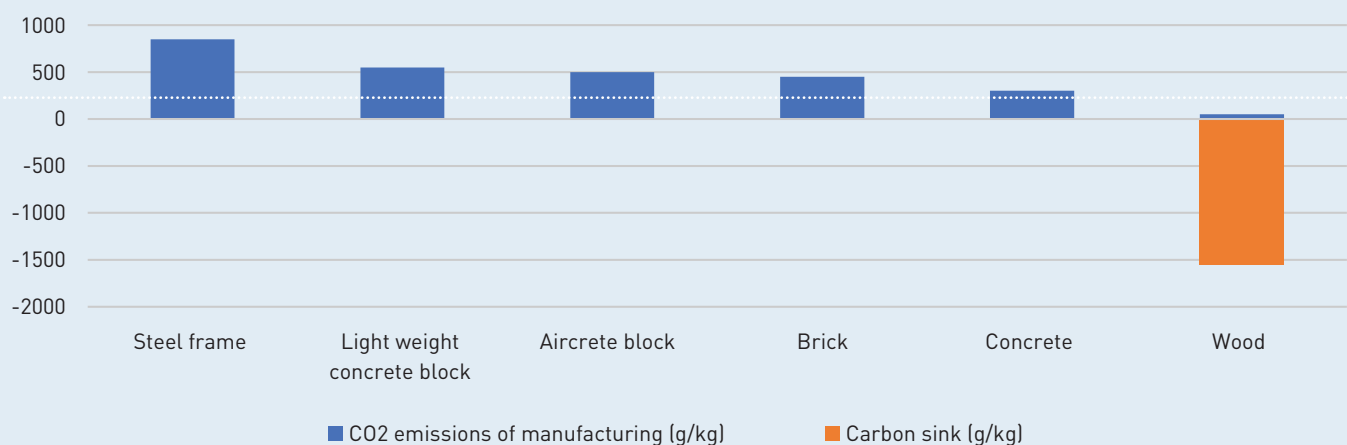


Figure 5 Carbon footprint of construction materials, including embodied carbon



Source: Dasos Capital: Wood building and real estate impact investing, Q1 2021

5. JLL, How is real estate innovating to cut embodied carbon?, Q4 2021

6. Dasos Capital, Wood building and real estate impact investing, Q1 2021

Prefabricated materials

The financial benefits of efficiency

A like-for-like cost comparison would indicate timber is currently more expensive than concrete or steel. This reflects supply and demand dynamics. However, as timber construction becomes more mainstream and less specialised, costs will become more competitive as timber construction expands its market presence.

Despite its higher cost, the speed of timber construction can shift the financial balance. Mass timber buildings are roughly 25% faster to construct than their concrete equivalents.⁷

This increased speed stems mostly from timber's lightweight nature which allows for larger and fewer lifts, as well as the ability for building sections to be prefabricated building offsite.

Prefabricated buildings comprise of component parts manufactured in remote factories, transported to site, and

assembled. Several studies exploring ways to improve building productivity recommend increasing the prefabricated portion⁸.

As well as faster construction times, prefabrication means better quality products, less waste and lower unit costs. Other benefits include improved health and safety alongside reduced onsite labour requirements. Carbon emissions from vehicle transport servicing prefabricated building sites can fall by up to 60% on top of significant reductions in noise and dust pollution⁹.

As urban residential densities rise, statutory constraints on traffic disruption and construction noise and dust will become more stringent. This will accelerate the move from on-site to off-site construction, increasing the appeal of timber buildings.

MYTH BUSTING:

Is timber susceptible to moisture damage?

Moisture damage is a common concern when discussing the risks involved in building with timber.

Timber's durability can be compromised by the sustained presence of water, while large moisture fluctuations can also impact its stability and performance. Water ingress management is therefore a critical part of the construction process.

As part of that process, manufacturers endeavour to protect joints and varnish and seal-up exposed end grains.

Every floor in the construction process will act as the roof at some point. Water will land on it and will need to be effectively drained. Some mass timber buildings use sacrificial waterproofing layers at various points to provide enough time to allow the next construction milestone to be achieved.

If water was to find a way in, there are certain measures that can be taken to remove it, such as using vacuums, fan heaters, or replacing the section of timber altogether.

When designed and maintained properly, timber buildings perform exceptionally well with many examples standing the test of time and lasted centuries such as the Hōryū-ji temple in Japan, and stave churches in Norway.

7. Think Wood, Four things to know about mass timber, Q1 2022

8. World Economic Forum and Boston Consulting Group, Shaping the Future of Construction: A Breakthrough in Mindset and Technology, 2016

9. Build off site, Offsite Construction: Sustainability Characteristics, Q2 2013



MYTH BUSTING:

How can cutting down trees be good for the environment?

To meet growing demand for timber, forests must be managed in a way that allows increased productivity while maintaining their environmental and social benefits. This includes carbon sequestration, wildlife habitat, water management, and recreation. All of this can be achieved through sustainable forest management.

Sustainable forest management supports actions that can increase the health and growth of trees. These include planting trees, using of fertiliser to supplement soil nutrients, managing understories, and thinning forests to reduce competition and increasing nutrient and light availability for tree growth.

Sustainable management can also support growth improvements before forests are even planted using improved genetic material either through breeding programs or clonal propagation.

Sustainable management should ensure species are matched to suitable sites and planted to maximise growth and carbon sequestration. As a result, the volume of trees and stored carbon will increase in regions with sustainable forest management alongside timber production as can be seen in Finland and the UK.

Forests which are poorly managed, or not managed at all are usually composed of trees that are dead or weakened from insect infestations. Decades of overzealous fire protection has left many forests choked with closely clustered, small-diameter trees. This increases forest fire risk which can leave permanent land-scarring. Across Europe, the area damaged by fire often exceeds 10 million hectares per year¹⁰. This is likely to rise due to climate change.

Ensuring timber production is sourced from sustainably managed forests is critical. Europe's forestry stock has actually increased by 10% since 1990 because more trees are being planted than felled as a result of management¹¹.

The three largest European forests used for mass timber are located in Finland, Sweden and Austria. These countries combined make up around one-third of Europe's forestry stock and have an average growth speed across of 2.75m³ of timber per second. The timber used in a typical 5,000 sqm office building would be regrown within nine minutes in an Austrian forest¹².

Spruce trees used for CLT buildings take about 70 years to reach maturity. The sweet spot for harvesting trees is between 50-70 years old as at this age they provide a good yield of timber, but it also means that they have absorbed a lot of carbon from the atmosphere.

Around 762 kilograms of carbon is stored within one cubic metre of CLT. This means that the construction of a 5,000 sqm office building using timber would remove around 1,000 tonnes of atmospheric carbon, which is the equivalent of 556 flights from London to Sydney¹³.

Overall, the use of mass timber in construction will benefit forests by not only increasing their volume, but also the health of the forest itself. Cutting down trees for timber buildings is thus good for the environment.

10. POYRY Assessment of the benefits of sustainable forest management, 2018

11. Eurostat, Q1 2022

12. Gardiner & Theobald, 2020

13. POYRY, Assessment of the benefits of sustainable forest management, 2018



Den Haag, Koningskade 30

Occupier demand

Rising desire for healthier premises

Occupiers increasingly want to lease space that aligns with their sustainability goals and demonstrates that they value their employee's health and wellbeing. Recent studies have shown biophilic workplace design incorporating plants and greenery can increase employee health and wellbeing by 13% and employee productivity by up to 8%¹⁴.

Another study measured the responses of subjects carrying out stress-inducing tasks in an environment devoid of timber surfaces, and one featuring timber. The results concluded that timber provides stress-reducing effects similar to the effect of nature exposure¹⁵.

As well as being aesthetically pleasing, mass timber is also a natural insulator. Timber in general has about one-third of the thermal insulating ability relative to a comparable thickness of fiberglass, about ten times of concrete and masonry, and 400 times of solid steel¹⁶. Mass timber can therefore

help to reduce temperature peaks and ultimately improve operational energy performance. This creates financial benefits to occupants through lower energy costs in addition to the environmental benefits.

Architects and interior designers are therefore encouraged to make holistic choices regarding materials, with buildings constructed from timber helping employers to attract and retain the best talent. Vasakronan, a Swedish real estate company, has found timber buildings are leased quicker, attract more interest from financial institutions and receive more competitive funding arrangements from banks¹⁷.

The current availability of mass timber buildings is low, allowing those that exist a competitive advantage in attracting occupiers and capturing rental premiums. Across European real estate this equates to a 9% premium based on our analysis¹⁸.

14. Stora Enso, Building Concepts, Q1 2018

15. Fell, D. R. Wood in the Human Environment: Restorative Properties of Wood in the Built Indoor Environment. PhD Thesis, University of British Columbia, 2010.

16. Vox, Susan Jones, Architect at Atelier Jones LLC, Q1 2020

17. Gardiner & Theobald, 2020

18. Cromwell Research – This was calculated by comparing the rents paid on recently let timber buildings compared to the local market prime rents.

MYTH BUSTING:

Are timber buildings a fire hazard?

Fire is typically the first concern that comes to mind when discussing the possibility of timber construction. However, there is now a great deal of evidence to demonstrate mass timber is as safe as steel when put to the test against fire.

Reports on CLT fire testing have come from the US Forest Service, the International Code Council, and the Fire Protection Research Foundation. The Forest Service has also undertaken extensive blast testing of CLT, which it comfortably passed opening the door to its use in military facilities.

In a fire, CLT will char on the outside, sealing the interior and protecting it from damage. Timber burns slowly at approximately 0.02 inches per minute¹. The char created on the timber surface as it burns helps to protect and insulate the unburnt timber below and maintain the structural integrity of

the building. This occurs because the carbon build-up on the surface limits oxygen supply, protecting the underlying timber. The timber below the charring will be cool and retain 85% to 90% of its structural integrity.

Mass timber has inherent fire-resistance properties but there are plenty of options for further enhancement. Timber can be made fire-retardant by applying a protective chemical or fire-resistant linings such as plasterboard. The flame spread on exposed timber can also be reduced through surface coating or impregnating chemical treatments.

Overall, mass timber is inherently fire-resistant and can remain structurally stable when subjected to high temperatures.

Insurance premiums A fast-evolving area

Timber building insurance premiums are currently higher in comparison to a more traditional building. This is not necessarily due to the perceived risk and nature of timber itself but rather a lack of available data to support a lower risk profile.

Insurers are data-driven and assess risk based on experience where possible. There is a lack of performance data and historical analysis covering timber buildings making it difficult for insurers to establish trends for set standards.

European insurers tend to rely on building codes, regulations and build methodologies from other regions such as North America. However, the use of timber in this region is often not comparable. North America usually undertakes a 'stick build' approach meaning timber structures are built on site using hand tools. If a 'stick build' is damaged by fire or flooding it tends to be catastrophic. This is not applicable to mass timber given its construction and engineering is completely different.

Thus lessons from the North American market is not an accurate comparison to assess insurance risk.

Investors can work with insurance to alleviate any undue fears on mass timber construction. Insurers require evidence of competency, credibility, a track record, and wish to understand safety measures against physical risks like fire or flooding. It is advantageous for developers to include them as early as possible and throughout the entire development journey.

Project teams who can collaborate well to demonstrate their collective understanding of potential risks will further improve an insurer's risk perception of mass timber buildings, meaning lower premiums. Greater timber building construction across Europe will increase the data available to insurers and reduce the assessment of risk.

Summary

Timber buildings are part of the solution

Achieving net zero carbon emissions by 2050 is comparable to the first Moon landing. We must recognise radical action is needed to meet this ambitious goal.

Like any new technology or idea, using timber as a construction material has its challenges. We have used concrete and steel construction for over a century. Our construction industry, techniques and regulations are predicated on this continuing method. The principal difficulty lies in redesigning the entire construction process.

As explored here, there are many clear benefits of timber construction from fewer carbon emissions to greater occupier demand. However, being a pioneer in a slow-moving industry can be daunting even for the most ambitious investors who recognise the performance benefits which often come from being a trailblazer.

Rising global emphasis on tackling climate change together with greater awareness of real estate's contribution to the

problem has brought about more awareness around the impact of traditional construction materials. This implies that interest in timber buildings will only grow.

In a market where investors are seeking to future-proof their assets, we believe interest in mass timber construction will grow significantly. Ultimately the success of timber buildings will be self-generating: the more timber is used, the more success stories there will be, the more the multi-faceted benefits will be evident to all. Combined with public education to debunk some of the common myths will position timber as the best choice in moving towards net zero.

Similar to electric cars, innovation in timber construction will create so much momentum to the point where it will not seem radical at all. We will simply be left asking - why did it take so long?





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