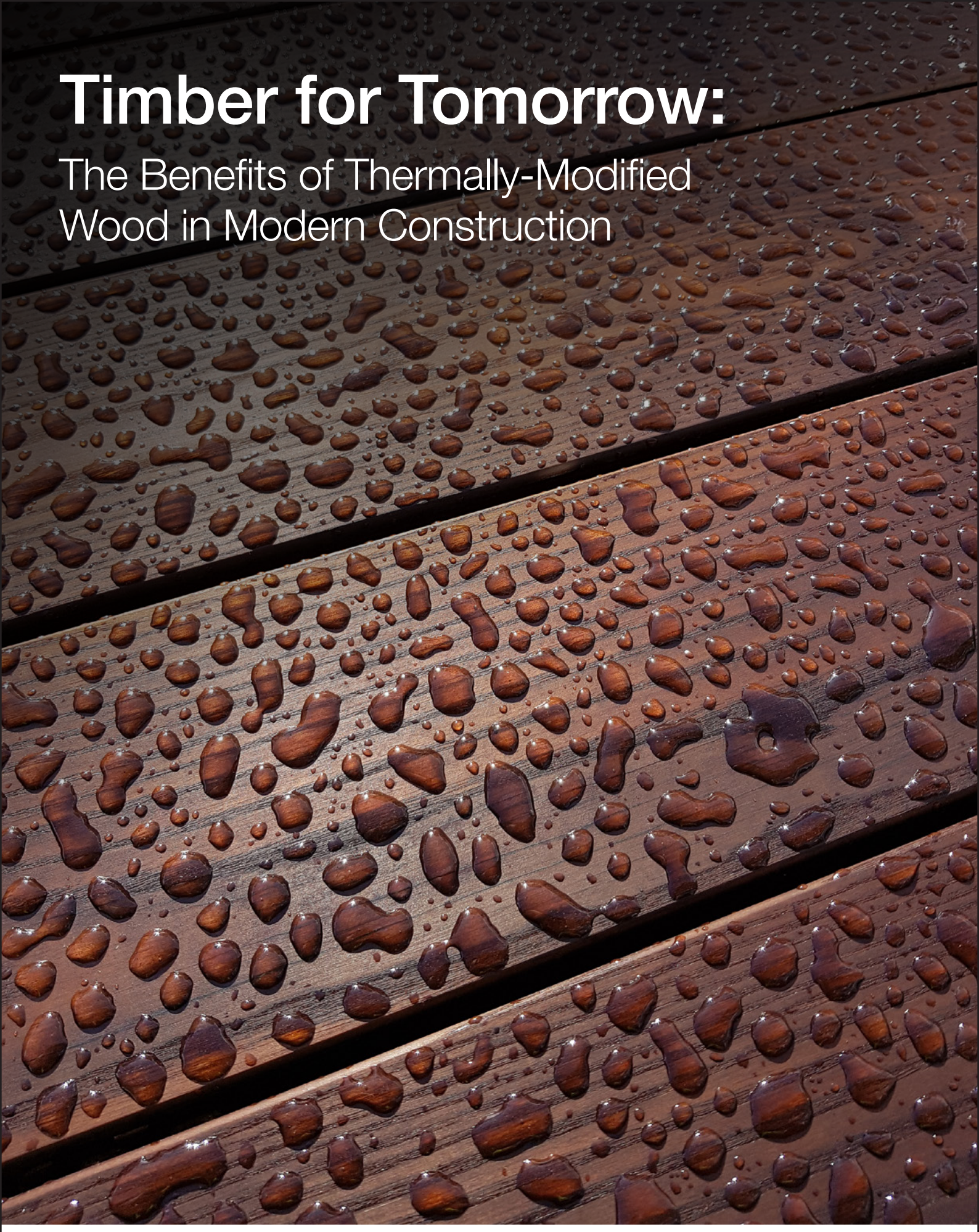
Timber for Tomorrow:

The Benefits of Thermally-Modified Wood in Modern Construction



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INTRODUCTION

Changing climatic conditions across the globe present a challenge for architects, designers and builders. Buildings must deliver aesthetics and long-lasting performance while withstanding the various effects of climate change, including harsher and more unpredictable weather conditions. To meet these requirements, most timbers on the market are chemically treated or naturally highly durable. However, both types of timber raise environmental and sustainability concerns due to the effects of chemical use and disposal, and wood sourcing from old-growth forests.

At the same time, the intensive use of materials such as concrete, steel and plastics is a growing global concern as the sustainability of modern construction comes into question. The need to decrease the energy consumption associated with the built environment highlights the role wood products can play in creating greener, more eco-friendly buildings. The energy needed to convert a tree into a usable product is significantly lower than other building materials with advantages in biodegradability and carbon take-up.

Due to its enhanced durability and stability, thermally-modified wood has emerged as a high performing, durable and sustainable alternative to conventional building materials, including traditional wood products.

In this whitepaper, we provide a close look at how thermally-modified wood is made and the benefits it offers to modern construction. We also discuss the key considerations when specifying thermally-modified wood for your next project.

WHAT IS THERMALLY-MODIFIED WOOD?

In its natural state, wood is a biodegradable and dimensionally unstable material. Without modification, these properties create design limitations and can lead to issues during its service life when used for building purposes. Thermal modification is a non-toxic commercial treatment process that is used to improve wood's material properties, including its dimensional stability and biological resistance.[1]

Open vs closed systems

Thermally-modified wood is modified by heating the material in high temperatures (>180 °C), changing its chemical structure.[2] There are two prevailing treatment processes for thermally modifying wood – the **open** system and the **closed** system. The open system utilises steam from a boiler system that is situated outside the chamber unit. The steam protects the wood while it is heated and affects the chemical changes taking place in the wood.[3] The closed system operates using high pressure (often above 100 psi) in a sealed, oxygen-free environment.[4]

The open system allows the humidity, surface temperature and core temperature of the wood and relative humidity in the chamber to be controlled, resulting in higher quality thermal modification and structural changes in the wood. This treatment process is more universal, reliable and suitable for complex processes and is the most common industrial thermal modification method in Europe.[5]

Thermal modification vs other wood treatments

Thermally-modified wood should not be confused with heat-treated wood or chemically-treated wood. Heat-treated wood is wood that is exposed to lower temperatures (approx. 55 °C) for the sole purpose of killing pests, such as in wooden pallets.[6] Chemically-treated wood has been treated with preservative chemicals to prevent rot, decay and/or improve its resistance to fire.

By comparison, thermal modification preserves wood's natural beauty and versatility and enhances its durability, stability and resistance to moisture, rot and pests, making it suitable for a wide variety of applications including external cladding, garden timber and deckings. Unlike chemically-treated wood, which can release harmful toxins if not handled correctly, thermally-modified wood does not contain carcinogens, toxins or other volatile organic compounds. This quality enables thermally-modified wood to be used in interior applications, where it is also valued for its visual appeal.

How is thermally-modified wood made?

The *Thermowood Handbook* describes the open system for manufacturing thermally-modified wood in three phases: [7]

- **Phase 1.** In the initial phase, wood is heated in special kilns, first by using heat and steam to raise the temperature rapidly to approximately 100ºC. The temperature is then steadily increased to 130ºC – during this period, high-temperature drying takes place and reduces the moisture content of the wood to nearly zero.
- **Phase 2.** After high-temperature drying has occurred, the temperature in the kiln is raised to a target temperature between 185ºC and 215ºC. When the target temperature is reached, this temperature is held constant for 2-3 hours depending on end-use application.
- **Phase 3.** This is the cooling and moisture conditioning phase. The temperature is lowered using water spray systems. When the temperature reaches 80-90ºC, re-moisturising takes place to increase the moisture content of the wood to a useable level (i.e. 4-7%).

During thermal modification treatment, steam is used as a protective vapour during drying and heat treatment, preventing the wood from burning.[8] Heating causes the wood to become less hydrophilic, while positively influencing some of its chemical properties, resulting in enhanced rot resistance, durability and dimensional stability and reduced water absorbency.[9] Different thermal modification levels can be applied depending on intended use.

When lowering or raising the temperature in the kiln, manufacturers use a special adjustment system to prevent surface and inside splitting and checking. Custom adjustment values are used for different wood species and dimensions.[10]

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BENEFITS OF THERMALLY-MODIFIED WOOD

Durability

The thermal modification process removes or changes a remarkable part of natural food sources in wood and triggers several changes in its chemical and structural composition. Thermally-modified wood contains much less hemicellulose than untreated wood. Under high temperatures, some resin and sugars are cooked out, removing nutrients and changing the remainder into less valuable energy resources for living organisms such as pests and fungi. Significantly less hemicellulose content means much less appeal for natural decomposers of wood. Thermal modification also lowers the wood's moisture absorbency, so it does not require further chemical protection from rot.

Studies have shown that thermally-modified wood maintained acceptable properties after natural and artificial weathering, making it suitable for external facade systems.[11] The chemical and structural enhancements caused by thermal modification increases the service life of wood materials without the use of toxic chemicals. Due to its superior durability and stability, thermally-modified wood has replaced tropical hardwood in some markets.

Dimensional stability

Thermally-modified wood has much higher dimensional stability than untreated wood. Generally, dimensional movement in thermally-modified hardwoods is twice less than in the same untreated wood. This is due to the significant reduction in equilibrium moisture content and the strengthening of the wood's molecular structure from thermal modification. These factors make the wood less absorptive and less susceptible to warping, swelling or shrinking regardless of variations in temperature and humidity.

This quality enables thermally-modified wood to overcome some of the design limitations of traditional treated wood. Thermally-modified wood retains its shape for longer, increasing its service life and maintaining optimum performance for a longer period of time. It also has exceptional resistance to heat and moisture, which allows it to outperform other timber products in a variety of weather conditions and in wet and/or high humidity areas.

Eco-friendly and sustainable

Increasing awareness of the impact of climate change has driven greater demand for sustainable development worldwide. Wood is gaining importance as a high performing building material that is renewable and unrivalled in terms of costs and environmental impact.[12] However, some wood species have poor resistance to biological degradation and low shape stability,[13] limiting their suitability for some building applications.

Thermally-modified wood is the superior wood product for sustainable building for the following reasons:

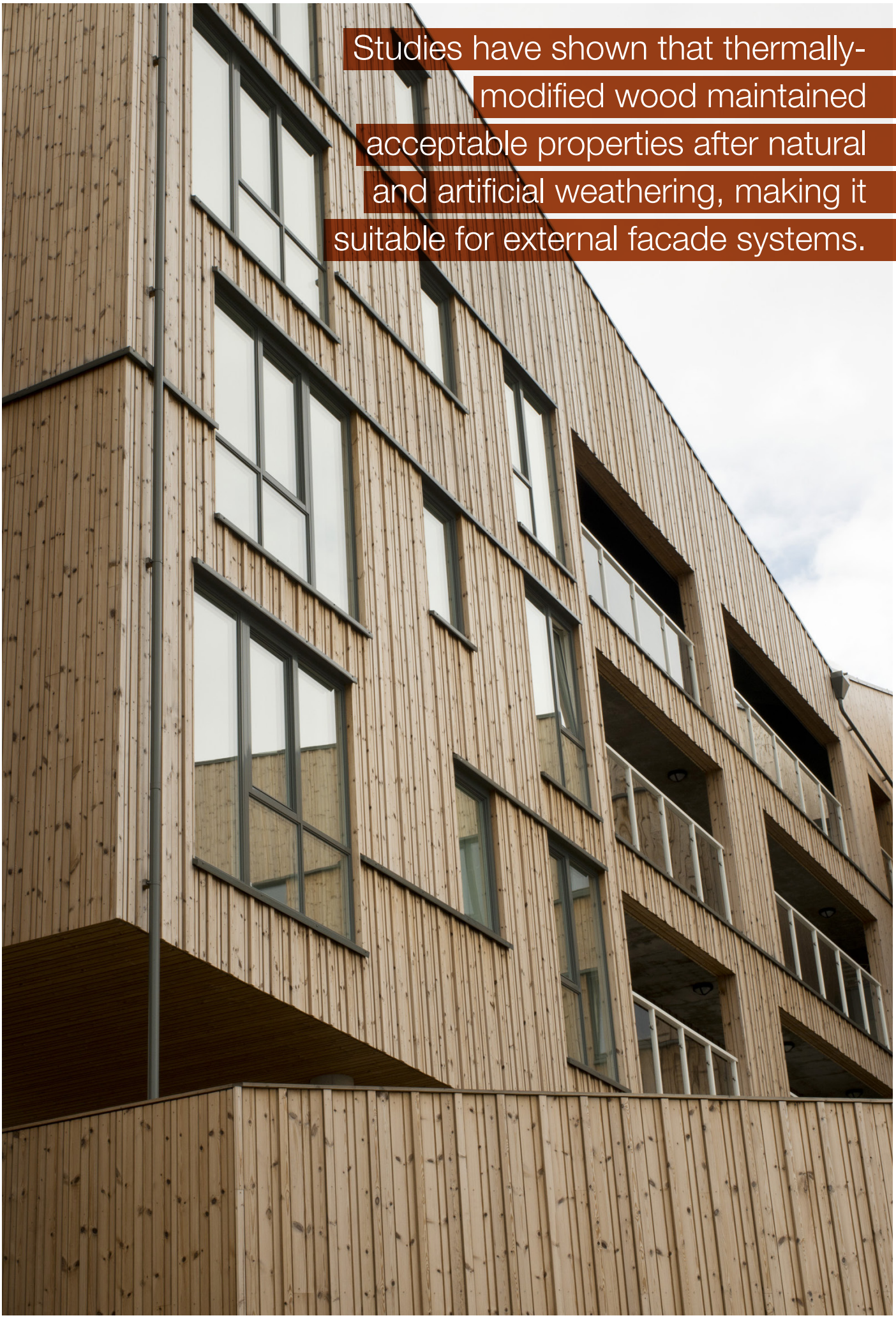
- Thermal modification improves the characteristics of wood such that it can be used for more building applications and with a longer service life.
- Thermally-modified wood is lightweight, which contributes to less energy-intensive construction.
- If it is sourced from sustainably-managed forests, thermally-modified wood has minimal impact on natural resources.
- Unlike chemical treatments, thermal modification is free of toxic substances that could otherwise be harmful to human health and the environment.

Low maintenance

Traditional treated wood has significant maintenance requirements, including ongoing staining, waterproofing and sealing. These treatments ensure the product maintains its look, performance and structural integrity overs its service life. Thermally-modified wood due to its enhanced properties, especially its resistance to water and decay, has comparatively reduced maintenance requirements and costs overall.

Lightweight

As thermal modification involves removing moisture from wood, rather than absorbing chemicals into the wood, the end product is lightweight. Thermally-modified wood not only enables lightweight and less energy-intensive construction methods, it is also easier to transport and work with, which saves projects time and reduces transport, installation and labour costs.



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SPECIFYING THERMALLY-MODIFIED WOOD

When specifying thermally-modified wood, ensure the selected product has a durability rating sufficient for the intended application. The durability rating is determined by the ability of the species to resist decay and insect pests (including termites) in accordance with *EN 350:2016 Durability of wood and wood-based products – Testing and classification of the durability to biological agents of wood and wood-based materials*. Class 1 (+25 years) and 2 (15-25 years) are the highest performing classifications. Products should be independently tested for durability.

Thermally-modified wood's unique aesthetic qualities should also be considered. The heat treatment in the thermal modification process darkens the wood, resulting in deeper and more vivid colours. The rich tone of thermally-modified wood can be preserved with UV protectant. However, note that the wood will nevertheless age and change colour over time.

Coated thermally-modified softwood products are available. Leading products are coated with water-based paints that are environmentally friendly and tested for weather resistance. Coated thermally-modified softwood has the benefit of Class 1 durability under the paint, enhanced dimensional stability to prevent unsightly issues like cupping, and no resin bleeding through the coating.

The user-friendliness of the thermally-modified wood product will contribute towards successful delivery of the project. Products that are easy to handle and install will reduce costs and construction time. Some leading cladding products feature advanced installation systems that enable quick installation through simple press-and-click fastening. Hidden fixing systems help maintain a clean look with no visible fastenings. End matching, which are pre-cut tongue and grooves on end of cladding and other wood products, allows cladding to be fitted easily together, cutting installation time and providing a consistent appearance.

Thermally-modified wood retains its shape for longer, increasing its service life and maintaining optimum performance for a longer period of time

THERMORY

For more than 20 years, Thermory has been a global leader in thermal modification – a sustainable technology for high quality lasting wood solutions. The company has worked closely with architects, designers, real estate developers and specialised distributors to deliver thousands of beautiful projects across 50+ countries on all continents.

Using only heat and steam, Thermory creates extremely durable and climate-resistant decking, cladding, flooring, wall paneling and sauna products that are unrivalled in both performance and sustainability versus the usual alternatives such as plastic composites, chemically-treated woods and tropical hardwoods.

Drift and Ignite by Thermory
– sustainable, functional and beautiful cladding
Thermory allows designers to elevate the aesthetics and performance of outer walls with a range of beautiful yet durable cladding materials created using its expert thermal modification process. The company's cladding range features a variety of textures, colours and finishes and innovations that enable fast installation and a smooth, splinter-free finish.

One such innovation is **Press and Click Strips (PACs)**, which is the easiest, and potentially the fastest, decking and cladding installation system on the market. PaCS let you easily and quickly install Thermory decking and cladding without damaging drill bits or wasting product. Pre-grooved boards offer automatic alignment with no visible screws, resulting in a flawless, durable finish in a matter of minutes.

Part of Thermory's quality exterior cladding range, **Drift** combines the stunning look of reclaimed wood with reliability, performance and durability. Available in a range of realistically-weathered colors, Drift uses thermally-modified spruce to create a weathered look that is nearly indistinguishable from reclaimed wood. Unlike reclaimed wood, which may be affected by risks and unknowns such as insect droppings, insecticides, lead, adhesives and stray nails, Drift boards are stunningly consistent in quality with exceptional stability and a 20+ year rot resistance rating.

A high performance alternative to traditional Japanese charred timber treatment, **Ignite** offers the shockingly realistic look of charred wood, while delivering durability all the way to the core and no messy residue. Ignite's unique dragon-scale pattern is created by embossing, brushing and tinting thermally-modified Scots pine in a flame-free process. Ignite's bold aesthetics are combined with superior stability and durability, and a 20+ year rot resistance rating.

Featuring a selection of beautiful, durable colors for outdoor cladding, the **Vivid Series** includes panels of thermally-modified spruce or pine that come factory painted, ready to install and with excellent resistance to decay and various weather conditions. Ideal as an exterior cladding solution, Vivid is available in a variety of colours and looks, including silvered, translucent and opaque tones, and a range of profiles.

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All information provided correct as of July 2020

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